HEATHKIT® MANUAL

for the

ELECTRONIC DESIGN EXPERIMENTER

Model ET-3100B

595-2860-03

EXTRA
BREADBOARD
CONN PINS

HEATH COMPANY • BENTON HARBOR, MICHIGAN

HEATH COMPANY PHONE DIRECTORY

The following telephone numbers are direct lines to the departments listed:

Kit orders and delivery information	(616) 982-3411
Credit	(616) 982-3561
Replacement Parts	(616) 982-3571

Technical Assistance Phone Numbers
8:00 A.M. to 4:30 P.M., EST, Weekdays Only

R/C, Audio, and Electronic Organs	(616) 982-3310
Amateur Radio	(616) 982-3296
Test Equipment, Weather Instruments and Home Clocks	(616) 982-3315
Television	(616) 982-3307
Aircraft, Marine, Security, Scanners, Automotive, Appliances and General Products	(616) 982-3496
Computers — Hardware	(616) 982-3309
Computers — Software: Operating Systems, Languages, Utilities	(616) 982-3860
Computers — Software: Application Programs	(616) 982-3884
Heath Craft Wood Works	(616) 982-3423

YOUR HEATHKIT 90-DAY LIMITED WARRANTY

Consumer Protection Plan for Heathkit Consumer Products

Welcome to the Heath family. We believe you will enjoy assembling your kit and will be pleased with its performance. Please read this Consumer Protection Plan carefully. It is a "LIMITED WARRANTY" as defined in the U.S. Consumer Product Warranty and Federal Trade Commission Improvement Act. This warranty gives you specific legal rights, and you may also have other rights which vary from state to state.

Heath's Responsibility

PARTS — Replacements for factory defective parts will be supplied free for 90 days from date of purchase. Replacement parts are warranted for the remaining portion of the original warranty period. You can obtain warranty parts direct from Heath Company by writing or telephoning us at (616) 982-3571. And we will pay shipping charges to get those parts to you . . . anywhere in the world.

SERVICE LABOR — For a period of 90 days from the date of purchase, any malfunction caused by defective parts or error in design will be corrected at no charge to you. You must deliver the unit at your expense to the Heath factory, any Heathkit Electronic Center (units of Veritechnology Electronics Corporation), or any of our authorized overseas distributors.

TECHNICAL CONSULTATION — You will receive free consultation on any problem you might encounter in the assembly or use of your Heathkit product. Just drop us a line or give us a call. Sorry, we cannot accept collect calls.

NOT COVERED — The correction of assembly errors, adjustments, calibration, and damage due to misuse, abuse, or negligence are not covered by the warranty. Use of corrosive solder and/or the unauthorized modification of the product or of any furnished component will void this warranty in its entirety. This warranty does not include reimbursement for inconvenience, loss of use, customer assembly, set-up time, or unauthorized service.

This warranty covers only Heath products and is not extended to other equipment or components that a customer uses in conjunction with our products.

SUCH REPAIR AND REPLACEMENT SHALL BE THE SOLE REMEDY OF THE CUSTOMER AND THERE SHALL BE NO LIABILITY ON THE PART OF HEATH FOR ANY SPECIAL, INDIRECT, INCIDENTAL OR CONSEQUENTIAL DAMAGES, INCLUDING BUT NOT LIMITED TO ANY LOSS OF BUSINESS OR PROFITS, WHETHER OR NOT FORSEEABLE.

Some states do not allow the exclusion or limitation of incidental or consequential damages, so the above limitation or exclusion may not apply to you.

Owner's Responsibility

EFFECTIVE WARRANTY DATE — Warranty begins on the date of first consumer purchase. You must supply a copy of your proof of purchase when you request warranty service or parts.

ASSEMBLY — Before seeking warranty service, you should complete the assembly by carefully following the manual instructions. Heathkit service agencies cannot complete assembly and adjustments that are customer's responsibility.

ACCESSORY EQUIPMENT — Performance malfunctions involving other non-Heath accessory equipment, (antennas, audio components, computer peripherals and software, etc.) are not covered by this warranty and are the owner's responsibility.

SHIPPING UNITS — Follow the packing instructions published in the assembly manuals. Damage due to inadequate packing cannot be repaired under warranty.

If you are not satisfied with our service (warranty or otherwise) or our products, write directly to our Director of Customer Service, Heath Company, Benton Harbor MI 49022. He will make certain your problems receive immediate, personal attention.

Heathkit® Manual

for the

ELECTRONIC DESIGN EXPERIMENTER

Model ET-3100B

595-2860-03

HEATH COMPANY
BENTON HARBOR, MICHIGAN 49022

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TABLE OF CONTENTS

Introduction 3

Parts List 7

Step-By-Step Assembly 9

Test and Adjustments 28

Final Assembly 29

Operation and Applications 30

In Case Of Difficulty 31
  Visual Checks 31
  Precautions For Troubleshooting 31
  Checking Transistors and Diodes 32
  Troubleshooting Chart 33

Specifications 34

Circuit Description 35
  Frequency Generator 35
  Power Supply 35

Semiconductor Identification Chart 36

Circuit Board X-Ray View .... (Illustration Booklet, Page 12)

Schematic .... (Illustration Booklet, Page 13)

Warranty .... Inside front cover

Customer Service .... Inside rear cover

INTRODUCTION

The Heathkit Model ET-3100B Electronic Design Experimenter is a compact, rugged, reliable, and versatile design instrument. With it, you can quickly build and test circuits that you have designed or want to experiment with.

The ET-3100B is also an excellent learning tool and is a recommended supplement to the individual learning programs of Heathkit/Zenith Educational Systems.

The Experimenter has the following built-in features:

- A variable and regulated, positive, 1.2 to 15 volt, DC power supply.
- A variable and regulated, negative, 1.2 to 15 volt, DC power supply.
- A 200 Hz to 20 kHz signal generator, with sine wave and square wave outputs.
- Two 60 Hz sine wave signal sources (15 volts and 30 volts).
- A large breadboarding socket.
- A 1000 (1k) Ω and a 100 kΩ experimentation potentiometer.

Most of the components are mounted on the circuit board. This makes the kit easy to assemble. The compact size and light weight allow you to move or place the Experimenter almost anywhere.

WARNING

Federal Communications Commission requirements prescribe verification of computing devices in Part 15 Subpart J of the rules and regulations. This computing device will meet these requirements when constructed in strict accordance with the instructions in this manual, using only components and materials supplied with the kit or the exact equivalent thereof.

This equipment generates and uses radio frequency energy for its operation and if not installed and used properly, that is, in strict accordance with the instruction manual, may cause interference to radio and television reception. It has been type tested and found to comply with the RF emission limits for a Class B computing device which is intended to provide reasonable protection against such interference in a residential installation. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

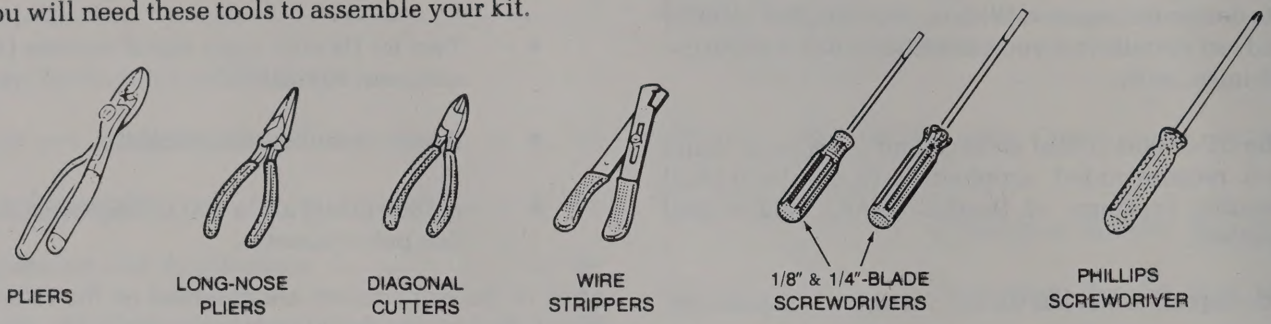
—Move the equipment away from the receiver being interfered with.
—Relocate the equipment with respect to the receiver.
—Reorient the receiving antenna.

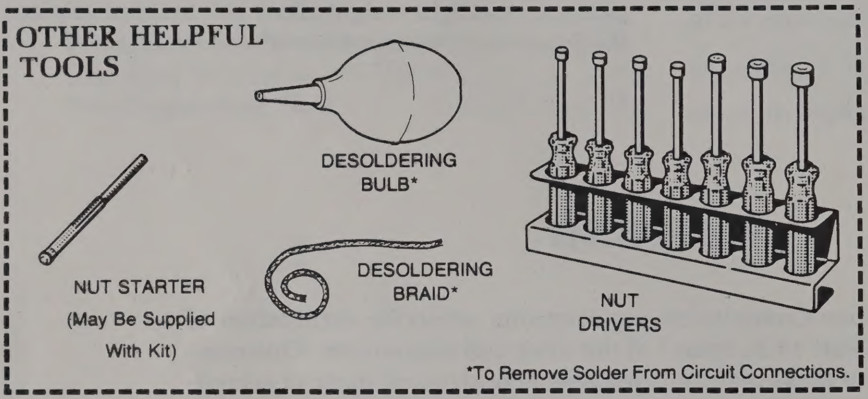
If additional help is needed, consult the dealer or ask for assistance from the manufacturer. Customer service information may be found on the inside back cover of this manual or on an insert sheet supplied with this equipment. The user may also find the following booklet helpful: "How to Identify and Resolve Radio-TV Interference Problems." This booklet is available from the US Government Printing Office, Washington, D.C. 20402 — Stock No. 004-000-00345-4

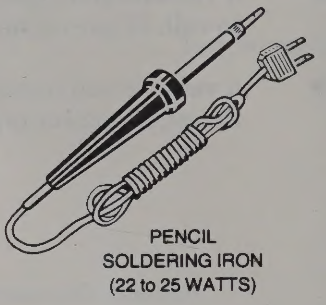
ASSEMBLY NOTES

TOOLS

You will need these tools to assemble your kit.




OTHER HELPFUL TOOLS
DESOLDERING BULB*
NUT STARTER (May Be Supplied With Kit)
DESOLDERING BRAID*
NUT DRIVERS
*To Remove Solder From Circuit Connections.


PENCIL SOLDERING IRON (22 to 25 WATTS)

ASSEMBLY

1. Follow the instructions carefully. Read the entire step before you perform each operation.

2. The illustrations in the Manual are called Pictorials and Details. Pictorials show the overall operation for a group of assembly steps; Details generally illustrate a single step. When you are directed to refer to a certain Pictorial "for the following steps," continue using that Pictorial until you are referred to another Pictorial for another group of steps.

3. Most kits use a separate "Illustration Booklet" that contains illustrations (Pictorials, Details, etc.) that are too large for the Assembly Manual. Keep the "Illustration Booklet" with the Assembly Manual. The illustrations in it are arranged in Pictorial number sequence.

4. Position all parts as shown in the Pictorials.

5. Solder a part or a group of parts only when you are instructed to do so.

6. Each circuit part in an electronic kit has its own component number (R2, C4, etc.). Use these numbers when you want to identify the same part in the various sections of the Manual. These numbers, which are especially useful if a part has to be replaced, appear:

   — In the Parts List,

   — At the beginning of each step where a component is installed,

   — In some illustrations,

   — In the Schematic,

   — In the section at the rear of the Manual.

7. When you are instructed to cut something to a particular length, use the scales (rulers) provided at the bottom of the Manual pages.

SAFETY WARNING: Avoid eye injury when you cut off excessive lead lengths. Hold the leads so they cannot fly toward your eyes.

SOLDERING

Soldering is one of the most important operations you will perform while assembling your kit. A good solder connection will form an electrical connection between two parts, such as a component lead and a circuit board foil. A bad solder connection could prevent an otherwise well-assembled kit from operating properly.

It is easy to make a good solder connection if you follow a few simple rules:

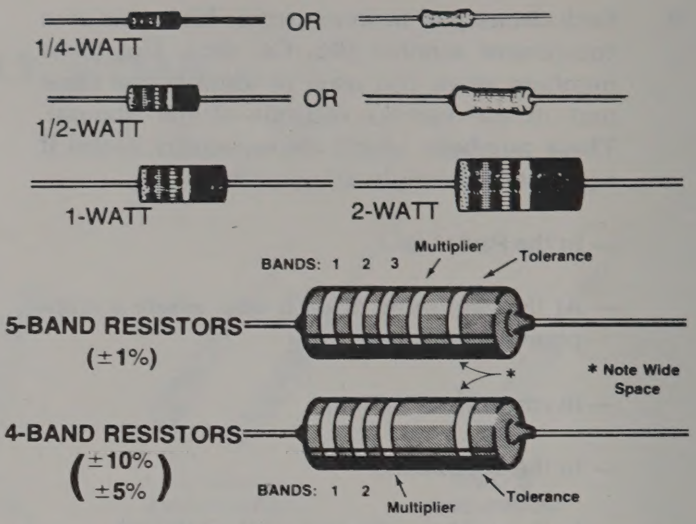
1. Use the right type of soldering iron. A 22 to 25-watt pencil soldering iron with a 1/8″ or 3/16″ chisel or pyramid tip works best.

2. Keep the soldering iron tip clean. Wipe it often on a wet sponge or cloth; then apply solder to the tip to give the entire tip a wet look. This process is called tinning, and it will protect the tip and enable you to make good connections. When solder tends to "ball" or does not stick to the tip, the tip needs to be cleaned and retinned.

NOTE: Always use rosin core, radio-type solder (60:40 tin-lead content) for all of the soldering in this kit. This is the type we have supplied with the parts. The Warranty will be void and we will not service any kit in which acid core solder or paste has been used.

PARTS

Resistors are identified in Parts Lists and steps by their resistance value in Ω (ohms), kΩ (kilohms), or MΩ (megohms). They are usually identified by a color code and four or five color bands, where each color represents a number. These colors (except for the last band, which indicates a resistor's "tolerance") will be given in the steps in their proper order. Therefore, the following color code is given for information only. NOTE: Occasionally, a "precision" or "power" resistor may have the value stamped on it.



Band 1 1st Digit	
Color	Digit
Black	0
Brown	1
Red	2
Orange	3
Yellow	4
Green	5
Blue	6
Violet	7
Gray	8
White	9

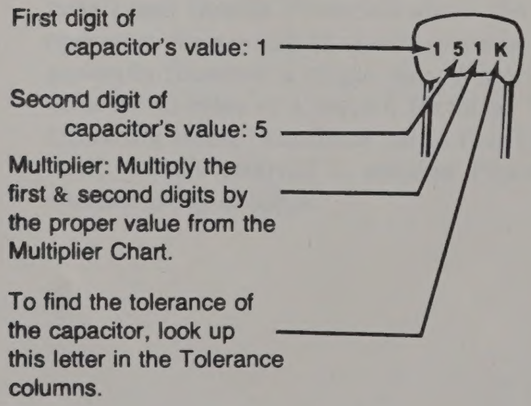
Band 2 2nd Digit	
Color	Digit
Black	0
Brown	1
Red	2
Orange	3
Yellow	4
Green	5
Blue	6
Violet	7
Gray	8
White	9

Band 3 (if used) 3rd Digit	
Color	Digit
Black	0
Brown	1
Red	2
Orange	3
Yellow	4
Green	5
Blue	6
Violet	7
Gray	8
White	9

Multiplier	
Color	Multiplier
Black	1
Brown	10
Red	100
Orange	1,000
Yellow	10,000
Green	100,000
Blue	1,000,000
Silver	0.01
Gold	0.1

Resistance Tolerance	
Color	Tolerance
Silver	±10%
Gold	± 5%
Brown	± 1%

Capacitors will be called out by their capacitance value in µF (microfarads) or pF (picofarads) and type: ceramic, Mylar*, electrolytic, etc. Some capacitors may have their value printed in the following manner:



First digit of capacitor's value: 1
1 5 1 K
Second digit of capacitor's value: 5
Multiplier: Multiply the first & second digits by the proper value from the Multiplier Chart.
To find the tolerance of the capacitor, look up this letter in the Tolerance columns.

EXAMPLES:

151K = 15 × 10 = 150 pF
759 = 75 ×0.1 = 7.5 pF

NOTE: The letter "R" may be used at times to signify a decimal point: as in: 2R2 = 2.2 (pF or µF).

MULTIPLIER		TOLERANCE OF CAPACITOR		
FOR THE NUMBER:	MULTIPLY BY:	10 pF OR LESS	LETTER	OVER 10 pF
0	1	±0.1 pF	B	
1	10	±0.25 pF	C	
2	100	±0.5 pF	D	
3	1000	±1.0 pF	F	±1%
4	10,000	±2.0 pF	G	±2%
5	100,000		H	±3%
			J	±5%
8	0.01		K	±10%
9	0.1		M	±20%

---

*DuPont Registered Trademark

PARTS LIST

Check each part against the following list and the "Parts Pictorial" (Illustration Booklet, Page 1 and 2). The key numbers correspond to the numbers on the "Parts Pictorial." Return any part that is packed in an individual envelope, with the part number on it, back into its envelope until that part is called for in a step. Do not throw away any packing material until you account for all the parts.

To order a replacement part, always include the PART NUMBER. Use the Parts Order Form furnished with this kit. If a Parts Order Form is not available, refer to "Replacement Parts" inside the rear cover of this Manual. For prices, refer to the separate "Heath Parts Price List."

RESISTORS

NOTE: The following resistors are 1/4-watt and have 5% tolerance (gold fourth band) unless stated otherwise.

KEY No.	HEATH Part No.	QTY.	DESCRIPTION	CIRCUIT Comp. No.
A1	6-189-12	2	1.8 Ω (brn-gray-gld)	R105,R115
A1	6-470-12	1	47 Ω (yel-viol-blk)	R8
A2	6-331-1	2	330 Ω, 1-watt (org-org-brn)	R102,R112
A1	6-561-12	1	560 Ω (grn-blu-brn)	R14
A1	6-392-12	1	3900 Ω (org-wht-red)	R15
A1	6-182-12	1	1800 Ω (brn-gry-red)	R101
A1	6-222-12	1	2200 Ω (red-red-red)	R13
A1	6-472-12	1	4700 Ω (yel-viol-red)	R12
A1	6-512-12	1	5100 Ω (grn-brn-red)	R3
A1	6-103-12	4	10 kΩ (brn-blk-org)	R1,R2,R11,R7
A1	6-333-12	1	33 kΩ (org-org-org)	R6
A1	6-563-12	2	56 kΩ (grn-blu-org)	R113,R103
A1	6-154-12	1	150 kΩ (brn-grn-yel)	R10
A1	6-334-12	1	330 kΩ (org-org-yel)	R4

CAPACITORS

KEY No.	HEATH Part No.	QTY.	DESCRIPTION	CIRCUIT Comp. No.
B1	20-198	1	5 pF mica	C2
B1	20-103	2	150 pF mica	C1,C7
B2	21-111	1	15 pF ceramic	C8
B2	21-163	2	.001 µF ceramic	C104,C114
B2	21-192	2	.1 (104M) µF ceramic	C102,C112
B3	27-70	2	.0022 µF Mylar	C5,C6
B3	27-137	2	.02 µF Mylar	C3,C4
B4	25-865	2	10 µF electrolytic	C103,C113
B4	25-876	2	1000 µF electrolytic	C101,C111

CONTROLS

KEY No.	HEATH Part No.	QTY.	DESCRIPTION	CIRCUIT Comp. No.
C1	10-1054	1	1000 (1k) Ω	R122
C1	10-1053	2	3000 (3k) Ω	R104,R114
C1	10-1055	1	100 kΩ	R121
C2	12-184	1	200 kΩ/5 kΩ dual	R5/R9

DIODES

KEY No.	HEATH Part No.	QTY.	DESCRIPTION	CIRCUIT Comp. No.
D1	56-56	4	1N4149	D1,D2, D106,D116
D1	56-99	2	1N5223B	ZD1,ZD2
D1	56-620	2	1N4744A	ZD101, ZD111
D1	57-65	4	1N4002	D101,D102, D103,D104
D2	412-640	1	LED LST5053 (red)	V101

TRANSISTORS — INTEGRATED CIRCUIT (IC)

NOTE: Transistors and the integrated circuit are marked for identification in one of the following four ways:

1. Part number.
2. Type number. (On the integrated circuit, use only the numbers. The letters may be different or missing.)
3. Part number and type number.
4. Part number with a type number other than the one listed.

KEY No.	HEATH Part No.	QTY.	DESCRIPTION	CIRCUIT Comp. No.
D3	417-235	3	2N4121 transistor	Q111,Q113, Q114
D3	417-801	5	MPSA20 transistor	Q1, Q2, Q101, Q103, Q104
D4	417-856	1	MJE5979 transistor	Q102
D4	417-857	1	MJE5976 transistor	Q112
D5	442-39	2	LM301 integrated circuit	U1, U2

SWITCHES — INSULATORS

KEY No.	HEATH Part No.	QTY.	DESCRIPTION	CIRCUIT Comp. No.
E1	60-78	1	DPDT slide switch	SW1
E2	60-607	1	SPST rocker switch	SW101
E3	73-92	1	Foam tape (5″ × 3/4″)	
E4	75-52	1	Switch insulator	
E5	75-724	1	Insulator plate	
E6	75-29	1	Strain relief	
	75-809	1	Insulator paper	

HARDWARE

NOTE: The hardware is shown full size so you can place any nut, screw, etc. you are uncertain about over the drawing. Also, the hardware may be packed in more than one packet. Open all the hardware packets (marked HDW) before you check the hardware against the Parts List.

#4 Hardware

KEY No.	HEATH Part No.	QTY.	DESCRIPTION	CIRCUIT Comp. No.
F1	250-163	3	#4 × 5/16″ self-tapping screw	
F2	250-1412	2	4-40 × 3/8″ screw	
F3	252-2	2	4-40 nut	
F4	254-9	2	#4 lockwasher	

#6 Hardware

KEY No.	HEATH Part No.	QTY.	DESCRIPTION	CIRCUIT Comp. No.
G1	250-1325	4	6-32 × 1/4″ screw	
G2	250-1420	1	6-32 × 3/8″ screw	
G3	250-1434	9	#6 × 3/8″ self-tapping screw	
G4	250-1435	1	#6 × 1/2″ self-tapping screw	
G5	250-1460	8	#6 × 5/8″ self-tapping flat head screw	
G6	250-1137	2	#6 × 1-1/8″ screw	
G7	252-3	1	6-32 nut	
G8	252-170	2	#6 brass insert	
G9	254-1	2	#6 lockwasher	

Other Hardware

KEY No.	HEATH Part No.	QTY.	DESCRIPTION	CIRCUIT Comp. No.
H1	253-9	1	#8 flat washer	
H2	252-7	5	Control nut	
H3	253-10	5	Control flat washer	
H4	254-4	5	Control lockwasher	

WIRE — SLEEVING — LINE CORD

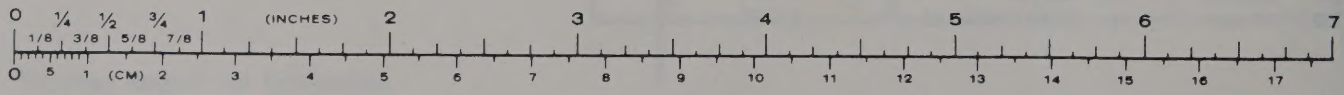
KEY No.	HEATH Part No.	QTY.	DESCRIPTION	CIRCUIT Comp. No.
	344-3	2′	Red stranded wire	
	344-52	5′	Red solid wire	
	344-50	5′	Black wire	
	344-51	3′	Brown wire	
	344-53	3′	Orange wire	
	344-54	5′	Yellow wire	
	344-55	3′	Green solid wire	
	344-155	15″	Green stranded wire	
	344-56	3′	Blue wire	
	346-1	6″	Small sleeving	
	346-35	2-1/2″	Heat-shrinkable sleeving	
	89-54	1	Line cord	

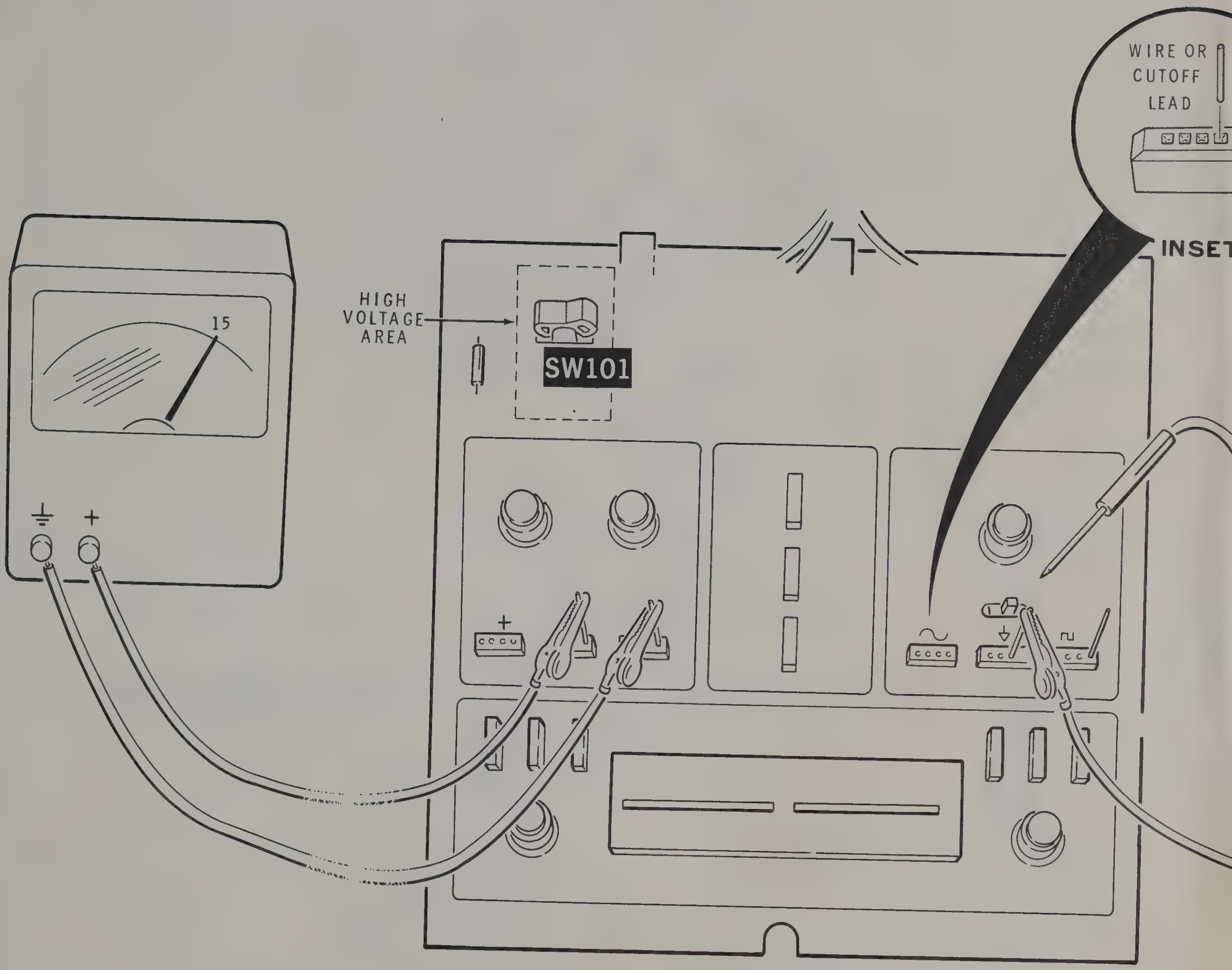
CONNECTORS — SOCKET

KEY No.	HEATH Part No.	QTY.	DESCRIPTION	CIRCUIT Comp. No.
J1	432-874	15	Wire connector	
J2	432-875	1	Breadboard	
J3	434-230	2	8-pin IC socket	

MISCELLANEOUS

KEY No.	HEATH Part No.	QTY.	DESCRIPTION	CIRCUIT Comp. No.
K1	54-1005	1	Transformer	T101
	85-2730-1	1	Circuit board	
K2	92-775	1	Cabinet top	
K3	92-776	1	Cabinet bottom	
K4	204-2539	1	Relief plate	
K5	207-3	1	Cable clamp	
K6	215-601	2	Heat sink	
K7	260-700	1	Plastic grommet	
K8	261-28	4	Foot	
K9	352-13	1	Grease	
K10	421-33	1	1/4-ampere slow-blow fuse	F101
K11	423-11	1	Fuseholder	
K12	455-50	5	Bushing	
K13	462-399	5	Knob	
K14	490-5	1	Nut starter	
K15	490-111	1	IC puller	
K16	390-1872	1	FCC label	
K17	390-2303	1	Nameplate	
K18	390-2328	1	Caution label	
K19		1	Blue and white label	
K20	431-44	1	4-lug terminal strip	
	597-260	1	Parts Order Form	
		1	Assembly Manual (see Page 1 for part number)	
			Solder	





PICTOR

SWITCHES — INSULATORS

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E3	73-92	1	Foam tape (5″ × 3/4″)	
E4	75-52	1	Switch insulator	
E5	75-724	1	Insulator plate	
E6	75-29	1	Strain relief	
	75-809	1	Insulator paper	

HARDWARE

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F3	252-2	2	4-40 nut
F4	254-9	2	#4 lockwasher

#6 Hardware

KEY No.	HEATH Part No.	QTY.	DESCRIPTION
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G2	250-1420	1	6-32 × 3/8″ screw
G3	250-1434	9	#6 × 3/8″ self-tapping screw
G4	250-1435	1	#6 × 1/2″ self-tapping screw
G5	250-1460	8	#6 × 5/8″ self-tapping flat head screw
G6	250-1137	2	#6 × 1-1/8″ screw
G7	252-3	1	6-32 nut
G8	252-170	2	#6 brass insert
G9	254-1	2	#6 lockwasher

Other Hardware

KEY No.	HEATH Part No.	QTY.	DESCRIPTION
H1	253-9	1	#8 flat washer
H2	252-7	5	Control nut
H3	253-10	5	Control flat washer
H4	254-4	5	Control lockwasher

WIRE — SLEEVING — LINE CORD

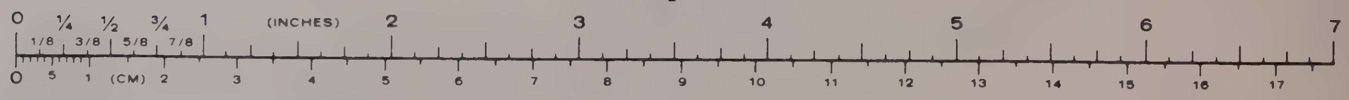
KEY No.	HEATH Part No.	QTY.	DESCRIPTION	CIRCUIT Comp. No.
	344-3	2′	Red stranded wire	
	344-52	5′	Red solid wire	
	344-50	5′	Black wire	
	344-51	3′	Brown wire	
	344-53	3′	Orange wire	
	344-54	5′	Yellow wire	
	344-55	3′	Green solid wire	
	344-155	15″	Green stranded wire	
	344-56	3′	Blue wire	
	346-1	6″	Small sleeving	
	346-35	2-1/2″	Heat-shrinkable sleeving	
	89-54	1	Line cord	

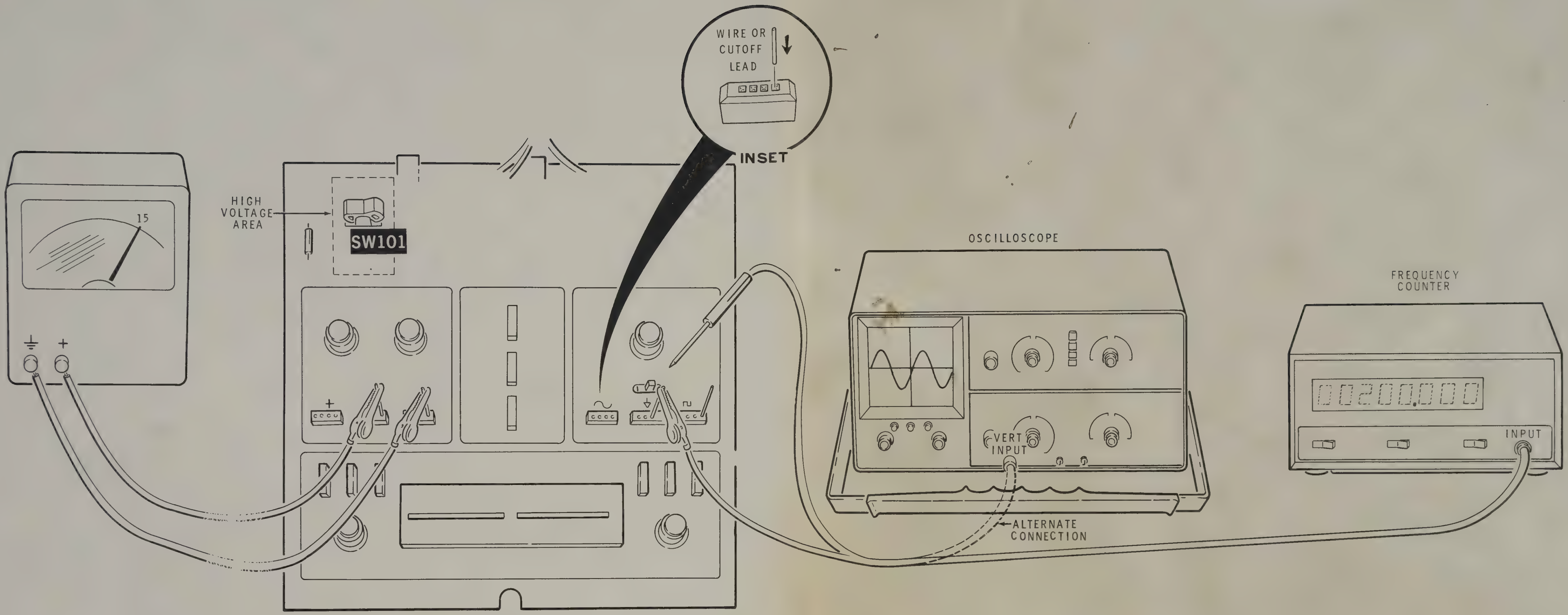
CONNECTORS — SOCKET

KEY No.	HEATH Part No.	QTY.	DESCRIPTION
J1	432-874	15	Wire connector
J2	432-875	1	Breadboard
J3	434-230	2	8-pin IC socket

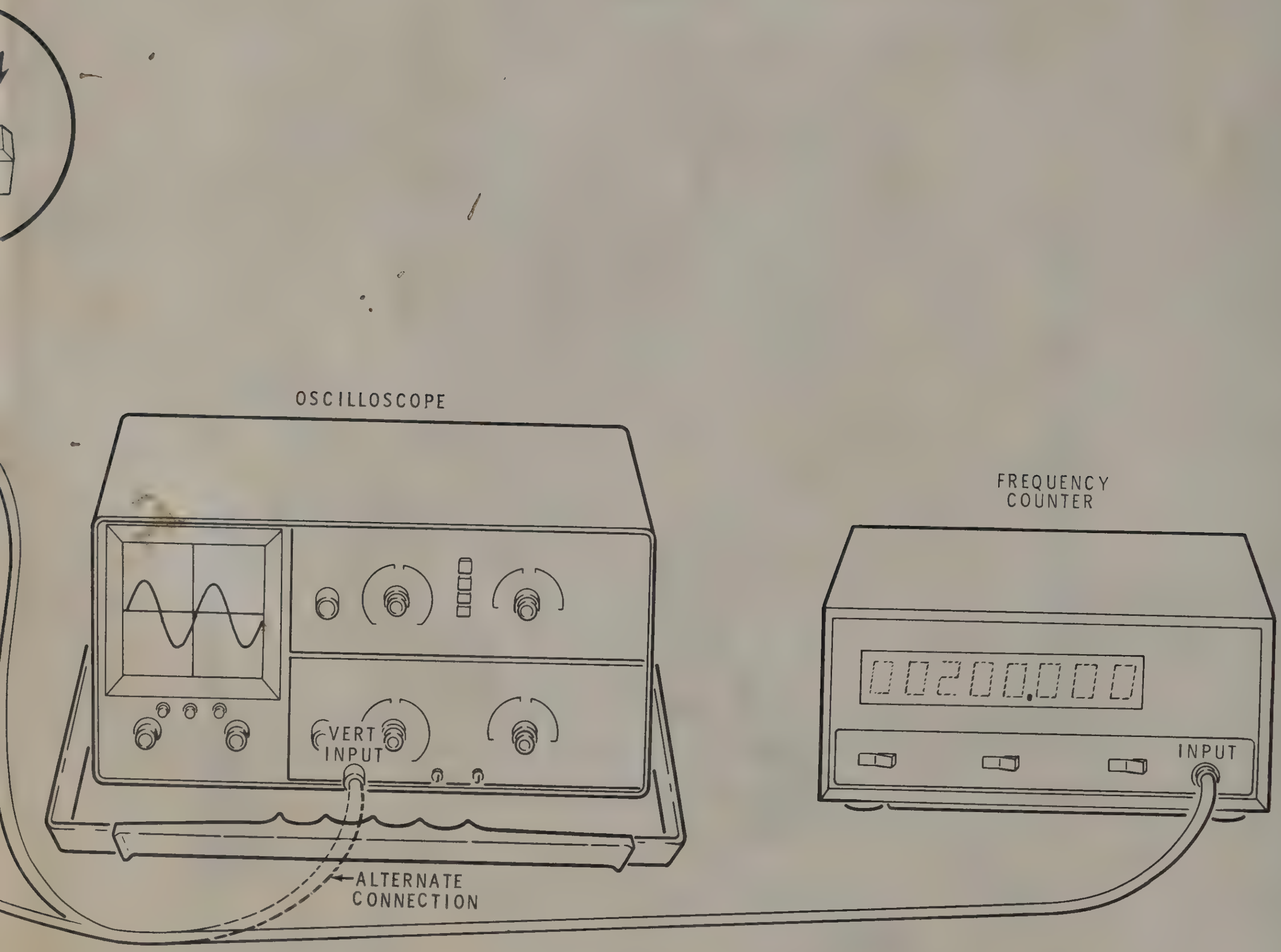
MISCELLANEOUS

KEY No.	HEATH Part No.	QTY.	DESCRIPTION	CIRCUIT Comp. No.
K1	54-1005	1	Transformer	T101
	85-2730-1	1	Circuit board	
K2	92-775	1	Cabinet top	
K3	92-776	1	Cabinet bottom	
K4	204-2539	1	Relief plate	
K5	207-3	1	Cable clamp	
K6	215-601	2	Heat sink	
K7	260-700	1	Plastic grommet	
K8	261-28	4	Foot	
K9	352-13	1	Grease	
K10	421-33	1	1/4-ampere slow-blow fuse	F101
K11	423-11	1	Fuseholder	
K12	455-50	5	Bushing	
K13	462-399	5	Knob	
K14	490-5	1	Nut starter	
K15	490-111	1	IC puller	
K16	390-1872	1	FCC label	
K17	390-2303	1	Nameplate	
K18	390-2328	1	Caution label	
K19		1	Blue and white label	
K20	431-44	1	4-lug terminal strip	
	597-260	1	Parts Order Form	
		1	Assembly Manual (see Page 1 for part number)	
			Solder	



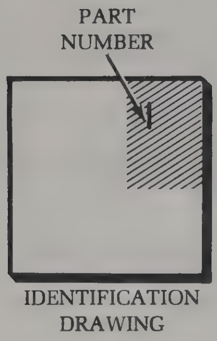


PICTORIAL 3-1


OSCILLOSCOPE
VERT INPUT
ALTERNATE CONNECTION
FREQUENCY COUNTER
00200.000
INPUT

IAL 3-1

STEP-BY-STEP ASSEMBLY



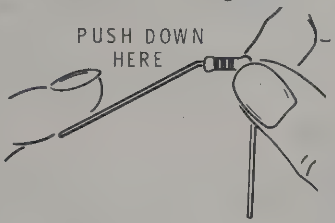
START

In the following steps, you will be given detailed instructions on how to install and solder the first part on the circuit board. Read and perform each step carefully. Then use the same procedure whenever you install parts on a circuit board.

The shaded area in the Identification Drawing at the top of each page indicates what portion of the circuit board you will be working with in each Pictorial. Always refer to the drawing before you begin the assembly.

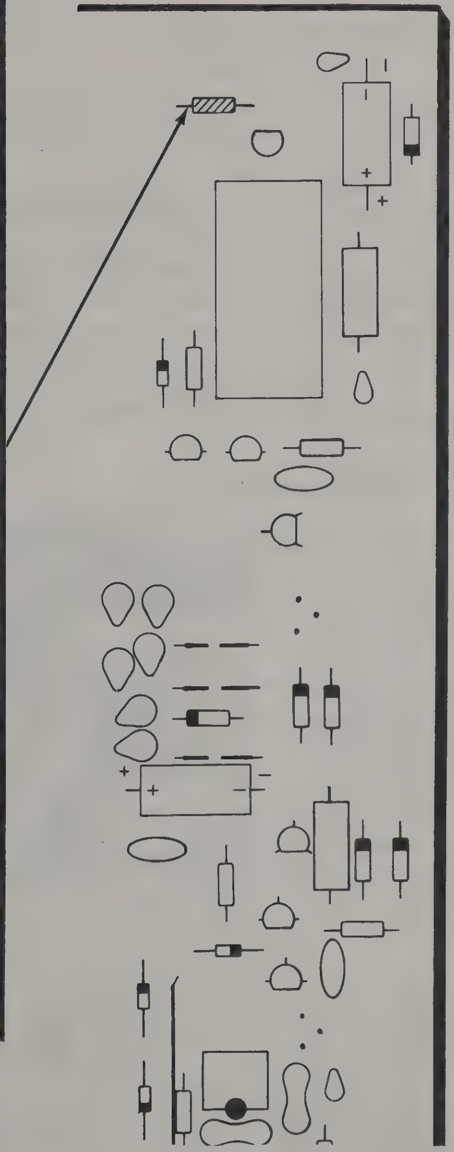
( ) Position the circuit board as shown with the printed side (not the foil side) facing up.

(✓) Hold a 1800 Ω (brn-gry-red) resistor by the body as shown and bend the leads straight down.



(✓) R101: Push the leads through the holes at the indicated location on the circuit board. The end with the color bands may be positioned either way.

( ) Press the resistor against the circuit board. Then bend the leads outward slightly to hold the resistor in place.

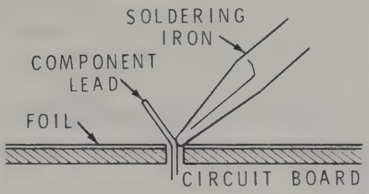


PICTORIAL 1-1

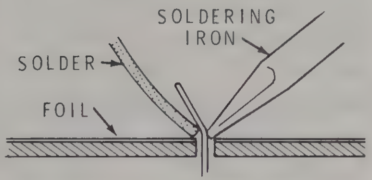
CONTINUE

( ) Turn the circuit board over and solder the resistor leads to the foil as follows:

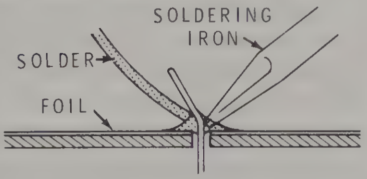
1. Push the soldering iron tip against both the lead and the circuit board foil. Heat **both** for two or three seconds.



2. Then apply solder to the other side of the connection. IMPORTANT: Let the heated lead and the circuit board foil melt the solder.

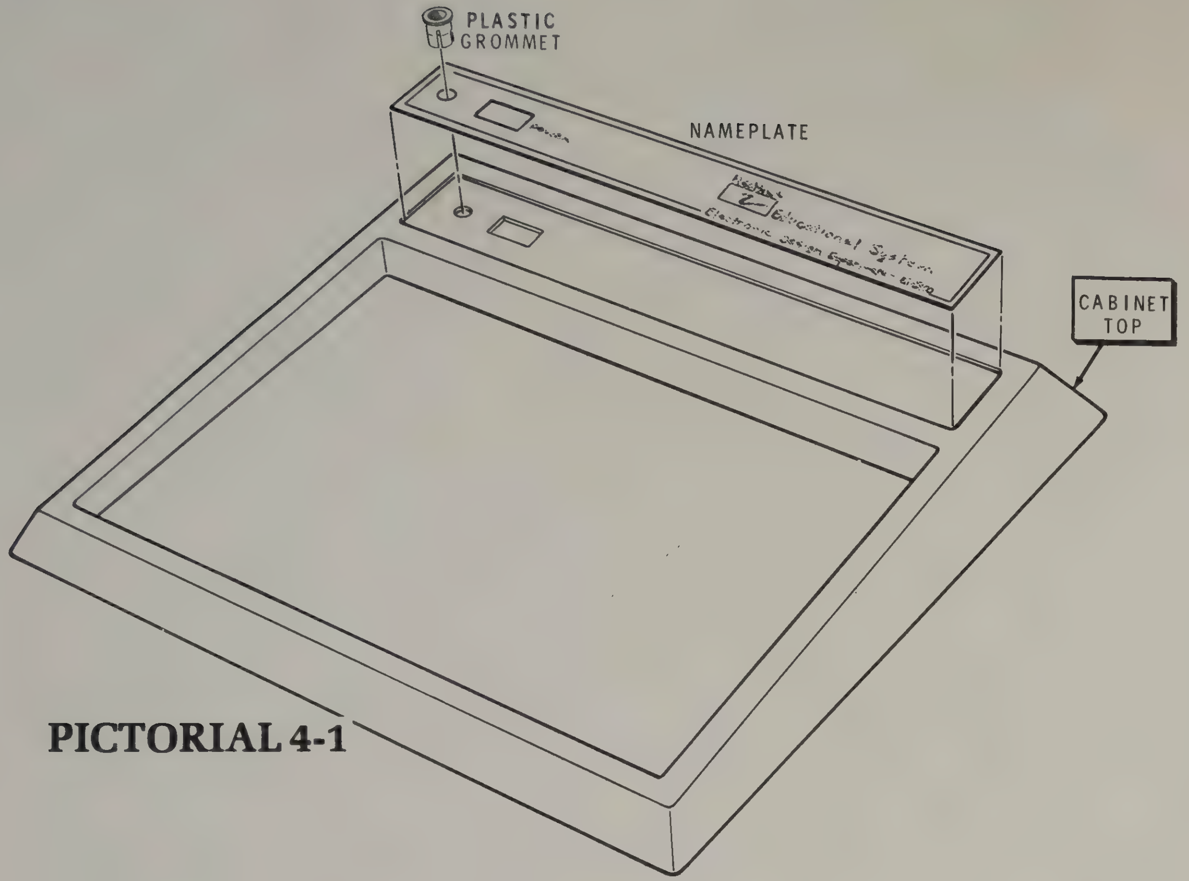


3. As the solder begins to melt, allow it to flow around the connection. Then remove the solder and the iron and let the connection cool.

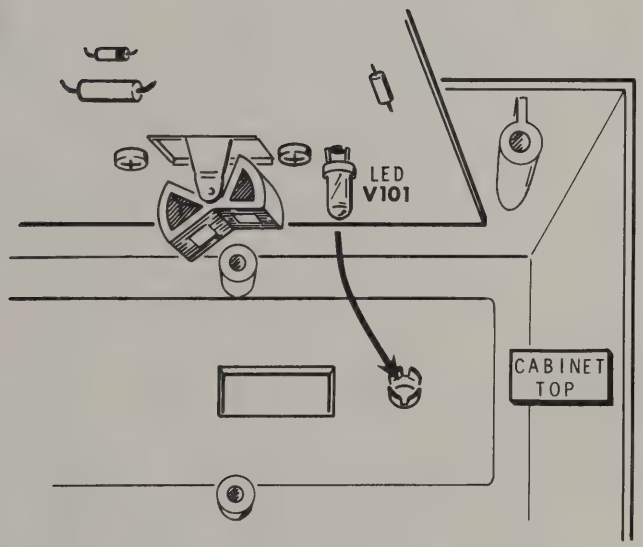


( ) Cut off the excess lead lengths close to the connection. WARNING: Clip the leads so the ends will not fly toward your eyes.

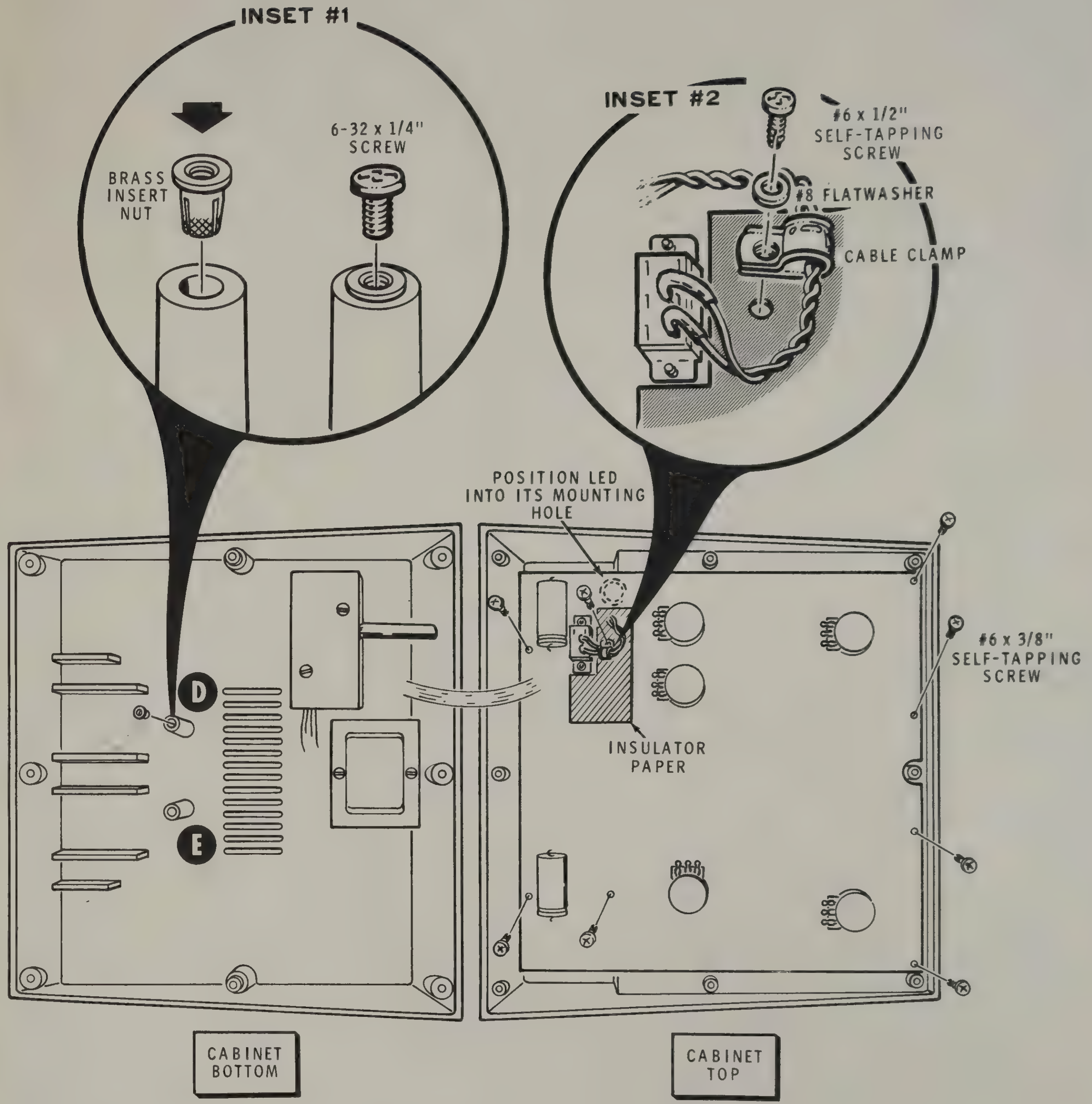
( ) Check the connections. Compare it to the illustrations on Page 10. After you have checked the solder connections, proceed with the assembly on Page 11. Use the same soldering procedure for each connection.



PICTORIAL 4-1



PICTORIAL 4-2A



PICTORIAL 4-2

STEP-BY-STEP ASSEMBLY

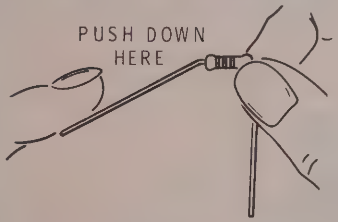
START

In the following steps, you will be given detailed instructions on how to install and solder the first part on the circuit board. Read and perform each step carefully. Then use the same procedure whenever you install parts on a circuit board.

The shaded area in the Identification Drawing at the top of each page indicates what portion of the circuit board you will be working with in each Pictorial. Always refer to the drawing before you begin the assembly.

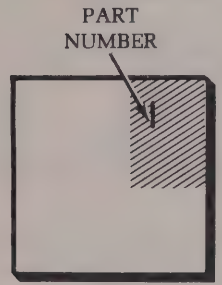
( ) Position the circuit board as shown with the printed side (not the foil side) facing up.

(✓) Hold a 1800 Ω (brn-gry-red) resistor by the body as shown and bend the leads straight down.

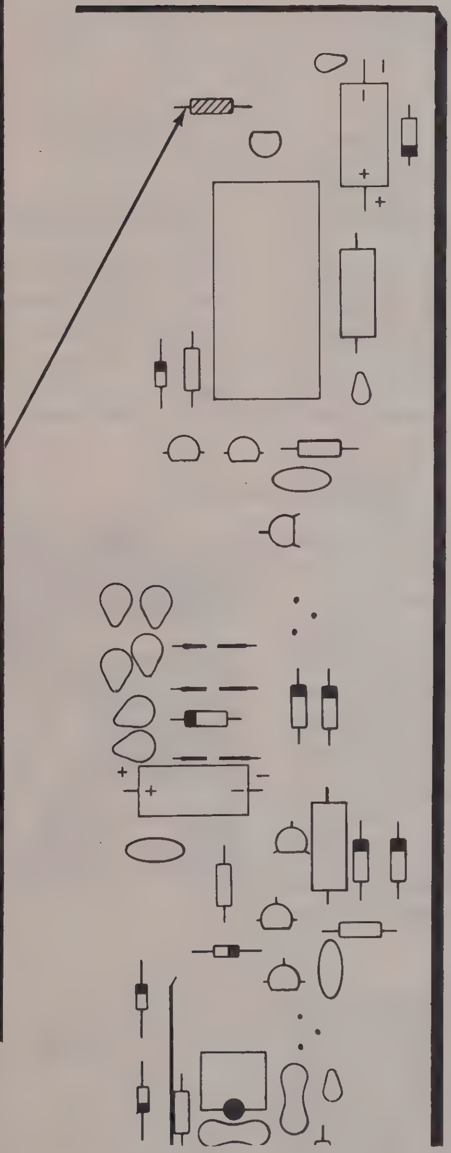


(✓) R101: Push the leads through the holes at the indicated location on the circuit board. The end with the color bands may be positioned either way.

( ) Press the resistor against the circuit board. Then bend the leads outward slightly to hold the resistor in place.



IDENTIFICATION DRAWING

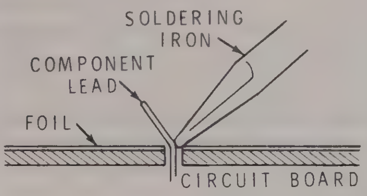


PICTORIAL 1-1

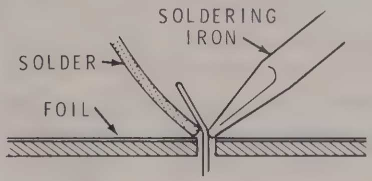
CONTINUE

( ) Turn the circuit board over and solder the resistor leads to the foil as follows:

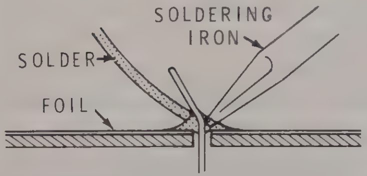
1. Push the soldering iron tip against both the lead and the circuit board foil. Heat **both** for two or three seconds.



2. Then apply solder to the other side of the connection. IMPORTANT: Let the heated lead and the circuit board foil melt the solder.



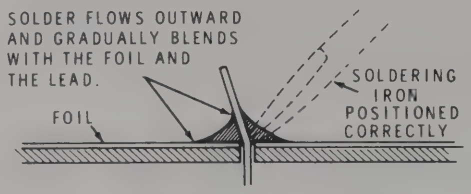
3. As the solder begins to melt, allow it to flow around the connection. Then remove the solder and the iron and let the connection cool.



( ) Cut off the excess lead lengths close to the connection. WARNING: Clip the leads so the ends will not fly toward your eyes.

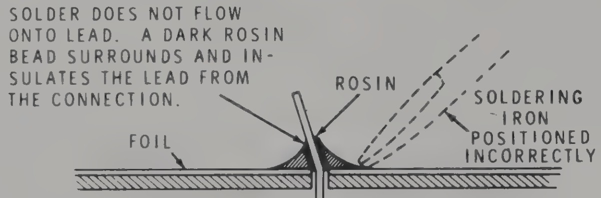
( ) Check the connections. Compare it to the illustrations on Page 10. After you have checked the solder connections, proceed with the assembly on Page 11. Use the same soldering procedure for each connection.

A GOOD SOLDER CONNECTION

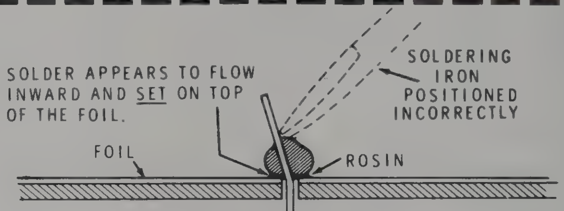

SOLDER FLOWS OUTWARD AND GRADUALLY BLENDS WITH THE FOIL AND THE LEAD.
FOIL
SOLDERING IRON POSITIONED CORRECTLY

When you heat the lead and the circuit board foil at the same time, the solder will flow evenly onto the lead and the foil. The solder will make a good electrical connection between the lead and the foil.

POOR SOLDER CONNECTIONS


SOLDER DOES NOT FLOW ONTO LEAD. A DARK ROSIN BEAD SURROUNDS AND INSULATES THE LEAD FROM THE CONNECTION.
ROSIN
FOIL
SOLDERING IRON POSITIONED INCORRECTLY

When the lead is not heated sufficiently, the solder will not flow onto the lead as shown above. To correct, reheat the connection and, if necessary, apply a small amount of additional solder to obtain a good connection.

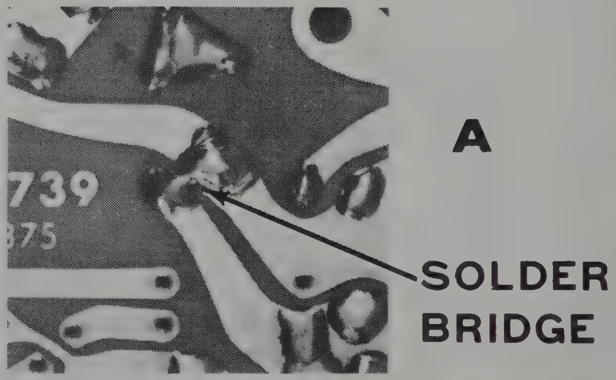

SOLDERING IRON POSITIONED INCORRECTLY
SOLDER APPEARS TO FLOW INWARD AND SET ON TOP OF THE FOIL.
FOIL
ROSIN

When the foil is not heated sufficiently the solder will blob on the circuit board as shown above. To correct, reheat the connection and, if necessary, apply a small amount of additional solder to obtain a good connection.

SOLDER BRIDGES

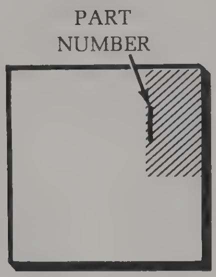
A solder bridge between two adjacent foils is shown in photograph **A**. Photograph **B** shows how the connection should appear. A solder bridge may occur if you accidentally touch an adjacent previously soldered connection, if you use too much solder, or if you "drag" the soldering iron across other foils as you remove it from the connection. A good rule to follow is: always take a good look at the foil area around each lead before you solder it. Then, when you solder the connection, make sure the solder remains in this area and does not bridge to another foil. This is especially important when the foils are small and close together. NOTE: It is alright for solder to bridge two connections on the same foil.

A



Use only enough solder to make a good connection, and lift the soldering iron straight up from the circuit board. If a solder bridge should develop, turn the circuit board foil-side-down and heat the solder between connections. The excess solder will run onto the tip of the soldering iron, and this will remove the solder bridge. NOTE: The foil side of most circuit boards has a coating on it called "solder resist." This is a protective insulation to help prevent solder bridges.

B

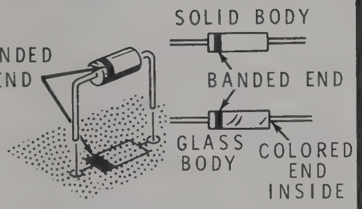


IDENTIFICATION DRAWING

START

NOTE: Make sure you installed the first part at R101 on Page 9.

NOTE: When you install a diode in the following steps, be sure to position the banded end as shown on the circuit board. THE CIRCUIT WILL NOT WORK IF A DIODE IS INSTALLED BACKWARDS.



CAUTION: ALWAYS POSITION THE BANDED END OF A DIODE AS SHOWN ON THE CIRCUIT BOARD.

If your diode has a solid body, the band is clearly defined. If your diode has a glass body, do not mistake the colored end inside the diode for the banded end. Look for a band painted on the outside of the glass. See Detail 1-2A.

(✓) ZD101: 1N4744A zener diode (#56-620).

(✓) R102: 330 Ω, 1-watt (org-org-brn).

(✓) R105: 1.8 Ω (brn-gry-gld).

(✓) D106: 1N4149 diode (#56-56).

(✓) R103: 56 kΩ (grn-blu-org).

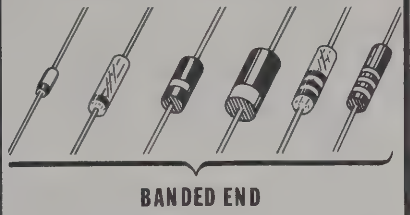
(✓) D102: 1N4002 diode (#57-65).

(✓) D104: 1N4002 diode (#57-65).

(✓) ZD111: 1N4744A zener diode (#56-620).

( ) Solder the leads to the foil and cut off the excess lead lengths.

NOTE: DIODES MAY BE SUPPLIED IN ANY OF THE FOLLOWING SHAPES. ALWAYS POSITION THE BANDED END AS SHOWN ON THE CIRCUIT BOARD.



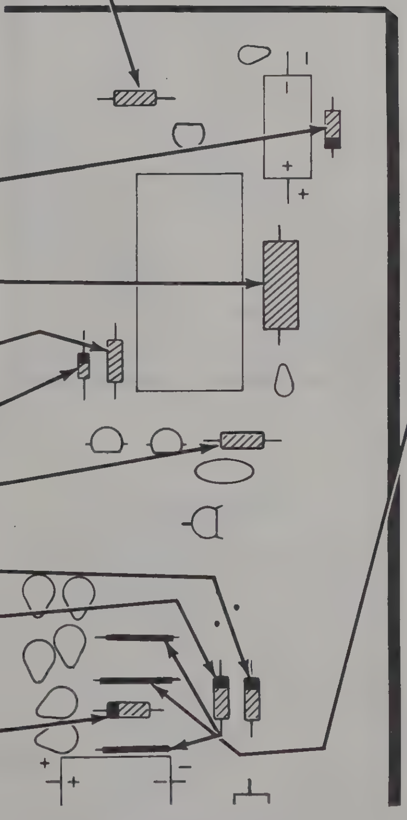
Detail 1-2A

CONTINUE

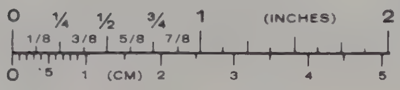
When a wire is called for, cut a yellow wire to the specified length. Then remove 1/4" of insulation from each end. Solder each wire end to the foil as you install it and cut off the excess wire ends.

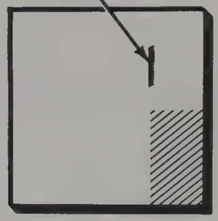
(✓) Install 1" wires at the three "J" locations.

(✓) Solder the wires to the foil and cut off the excess wire lengths.



PICTORIAL 1-2

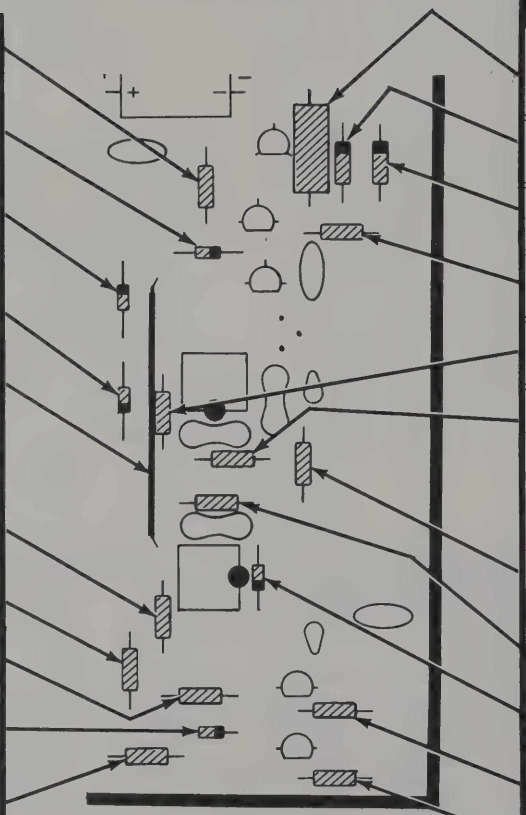




IDENTIFICATION
DRAWING

START

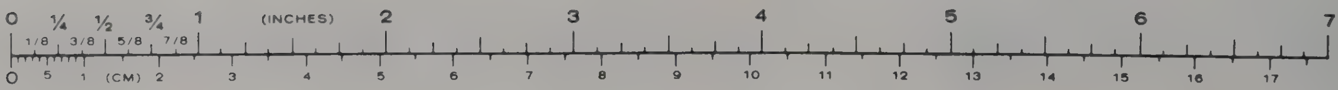
- (✓) R115: 1.8 Ω (brn-gry-gld).
- (✓) D116: 1N4149 diode (#56-56).
- (✓) ZD2: 1N5223B zener diode (#56-99).
- (✓) ZD1: 1N5223B zener diode (#56-99).
- (✓) 2-1/4" wire (yellow).
- ( ) Solder the leads to the foil and cut off the excess lead lengths.
- (✓) R10: 150 kΩ (brn-grn-yel).
- (✓) R14: 560 Ω (grn-blu-brn).
- (✓) R11: 10 kΩ (brn-blk-org).
- (✓) D2: 1N4149 diode (#56-56).
- (✓) R15: 3900 Ω (org-wht-red).
- ( ) Solder the leads to the foil and cut off the excess lead lengths.



PICTORIAL 1-3

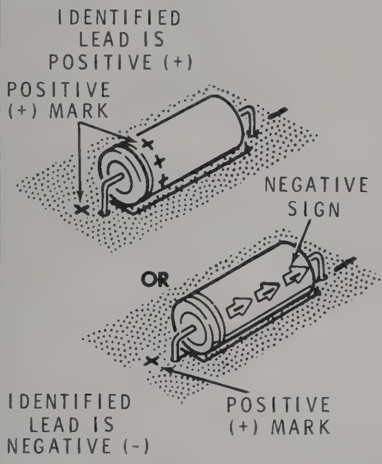
CONTINUE

- (✓) R112: 330 Ω, 1-watt (org-org-brn).
- (✓) D103: 1N4002 diode (#57-65).
- (✓) D101: 1N4002 diode (#57-65).
- (✓) R113: 56 kΩ (grn-blu-org).
- (✓) R3: 5100 Ω (grn-brn-red).
- (✓) R1: 10 kΩ (brn-blk-org).
- ( ) Solder the leads to the foil and cut off the excess lead lengths.
- (✓) R2: 10 kΩ (brn-blk-org).
- (✓) R4: 330 kΩ (org-org-yel).
- (✓) D1: 1N4149 diode (#56-56).
- (✓) R12: 4700 Ω (yel-viol-red).
- (✓) R13: 2200 Ω (red-red-red).
- ( ) Solder the leads to the foil and cut off the excess lead lengths.



START

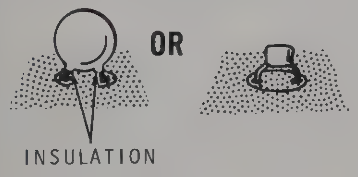
NOTE: Before you install an electrolytic capacitor, look at it and identify the leads. One lead will have a positive (+) mark or a negative (−) mark near it. **Be sure** to install the positive lead in the positive-marked hole. Be careful; only the negative lead may be marked.


IDENTIFIED LEAD IS POSITIVE (+)
POSITIVE (+) MARK
NEGATIVE SIGN
OR
IDENTIFIED LEAD IS NEGATIVE (-)
POSITIVE (+) MARK

(✓) C103: 10 μF electrolytic.

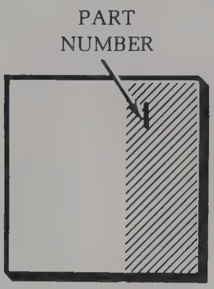
(✓) C113: 10 μF electrolytic.

NOTE: When you install ceramic capacitors, do not push the insulated portion of the leads into the circuit board holes. This could make it difficult to solder the leads to the foil.

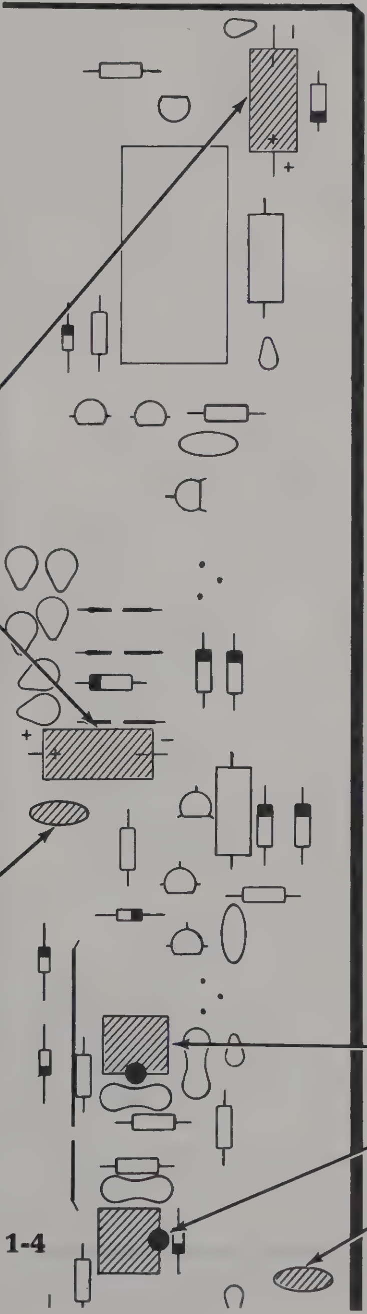


(✓) C102: .1 (104M) μF ceramic

( ) Solder the leads to the foil and cut off the excess lead lengths.



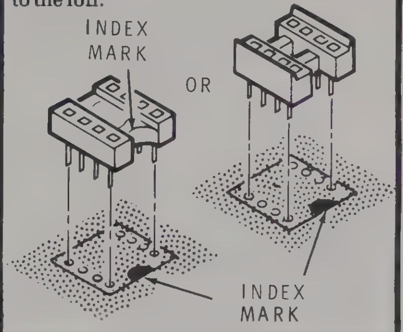
IDENTIFICATION DRAWING



PICTORIAL 1-4

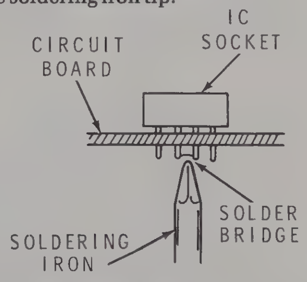
CONTINUE

NOTE: To install an 8-pin IC socket, make sure the socket pins are straight and that all of the pins go into the circuit board holes. The index mark on the circuit board must be visible after the socket is installed. Solder the pins to the foil.



NOTE: It is very easy to form a solder bridge between foils on the circuit board. After each solder step, carefully inspect the foil for solder bridges and remove any that may have formed.

If a solder bridge has occurred, hold the circuit board foil-side-down as shown, and hold the soldering iron tip between the two points that are bridged. The solder will flow down the soldering iron tip.



(✓) 8-pin IC socket at U1.

(✓) 8-pin IC socket at U2.

(✓) C112: .1 (104M) μF ceramic.

( ) Solder the leads to the foil and cut off the excess lead lengths.

START

(✓) C104: .001 μF ceramic.

(✓) C114: .001 μF ceramic.

(✓) C1: 150 pF mica.

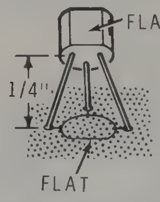
(✓) C2: 5 pF mica.

(✓) C7: 150 pF mica.

( ) Solder the leads to the foil and cut off the excess lead lengths.

CONTINUE

NOTE: When you install transistors, be sure the case bottom of each transistor is not more than 1/4" above the circuit board. Insert the transistor leads into the corresponding E, B, and C holes in the circuit board as shown. Solder each lead to the foil and cut off the excess lead lengths.



Install three MPSA20 transistors (#417-801) as follows:

(✓) Q103.

(✓) Q104.

(✓) Q101.

Install three 2N4121 transistors (#417-235) as follows:

(✓) Q114.

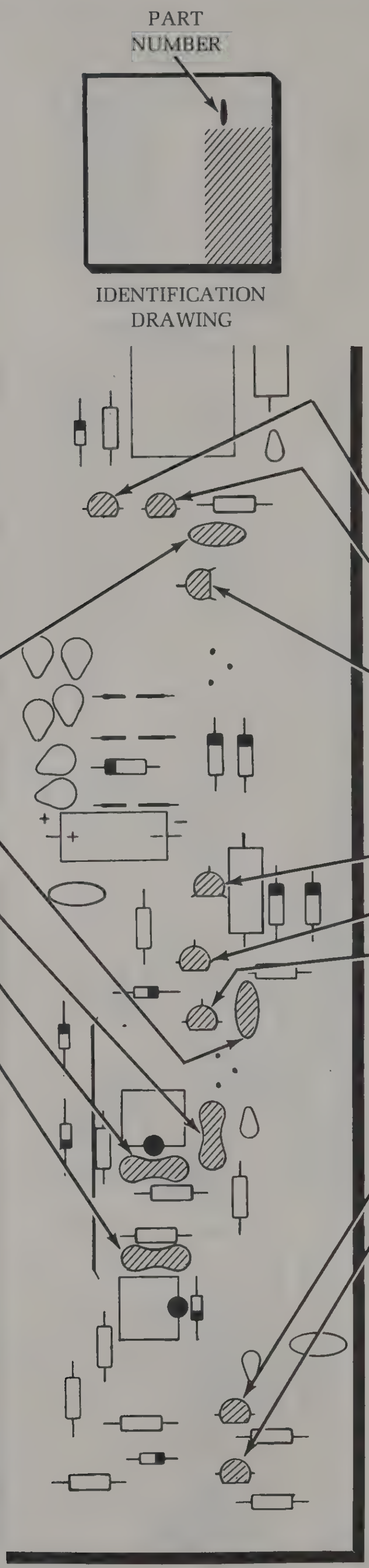
(✓) Q113.

(✓) Q111.

Install two MPSA20 transistors (#417-801) as follows:

(✓) Q1.

(✓) Q2.

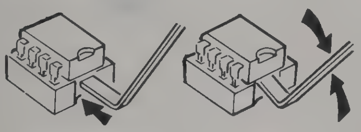


PICTORIAL 1-5

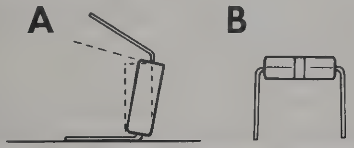
START

(✓) V101: Mount the LED (#412-640) at V101. Position the case flat over the flat on the circuit board. Insert the leads into the holes and position the case bottom 1/4" above the circuit board. Solder the leads to the foil and cut off the excess lead lengths.

NOTE: An IC puller has been included with this kit so you do not bend the pins in case you should have to remove an IC from its socket. To use the puller, insert its foot beneath the IC; then gently rock the tool back and forth to lift the IC.

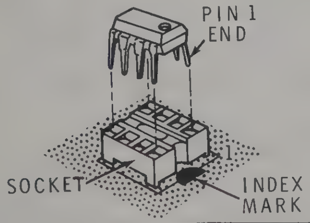


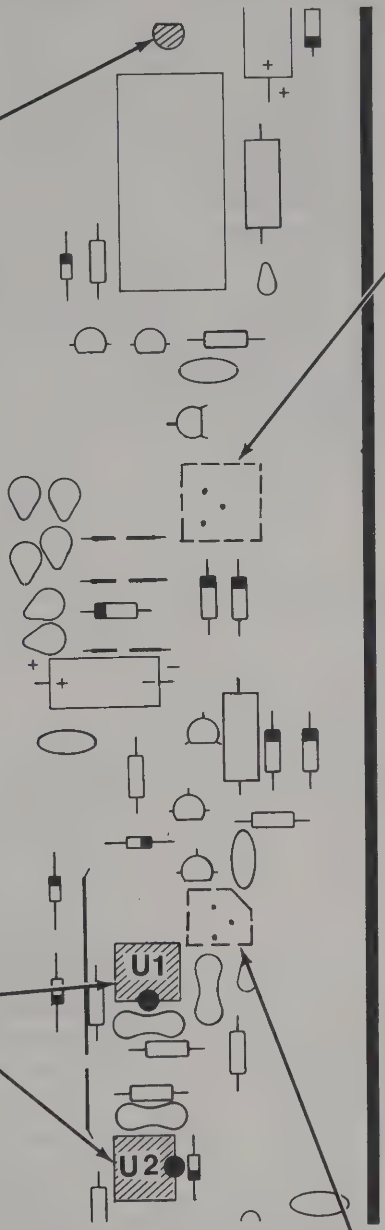
Before you install an IC, first be sure the pins are straight. Then lay it down on one of its rows of pins, as shown at A and roll it over until the pins are at right angles or bent in slightly as shown at B. Repeat this process for the other row of pins.



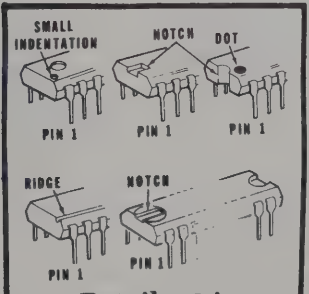
( ) U1 and U2: Mount the LM301 integrated circuits (#442-39) as follows:

1. Refer to Detail 1-6A and identify the pin 1 end of the integrated circuit.
2. Position the pin 1 end of the integrated circuit over the dot on the circuit board.
3. Carefully install the integrated circuit. Make sure all of the pins are in their respective holes and none of them are bent under the body.





PICTORIAL 1-6

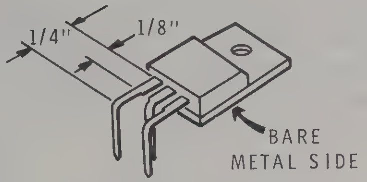


Detail 1-6A

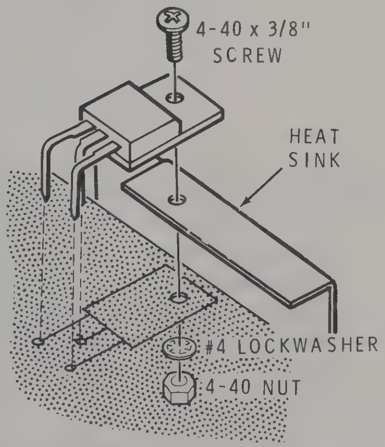
CONTINUE

( ) Q102: Mount the MJE5979 transistor (#417-856) as follows:

1. Position the bare metal side of the transistor down and bend the transistor leads as shown.



2. Open the container of grease and spread a liberal amount of grease onto the bare metal side of the transistor.
3. Install the E, C, and B leads into the corresponding holes in the circuit board and secure the transistor to the board with a heat sink, 4-40 × 3/8" screw, #4 lockwasher, and 4-40 nut. Use the plastic nut starter to hold and start the 4-40 nuts on the screws.
4. Solder the leads to the foil and cut off the excess lead lengths.



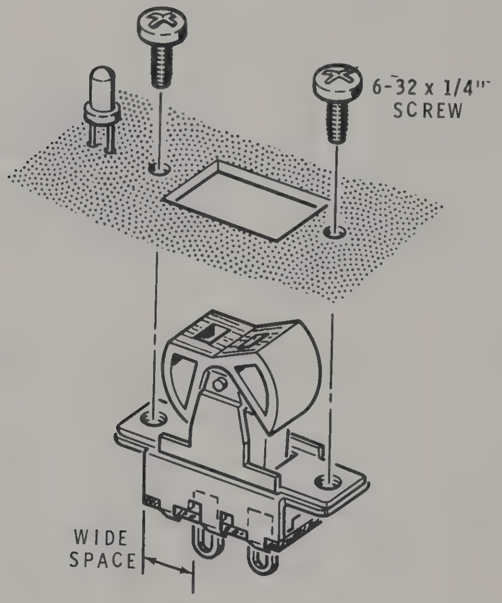
( ) Q112: MJE5976 transistor (#417-857). Install this transistor in the same way you installed the previous transistor.

Refer to Pictorial 1-7 (Illustration Booklet, Page 3) for the following steps.

(/) Position the circuit board as shown.

(/) SW101: Refer to Detail 1-7A and mount the SPST rocker switch at SW101 with two 6-32 × 1/4" screws. Be sure the switch is positioned with the wide space as shown.

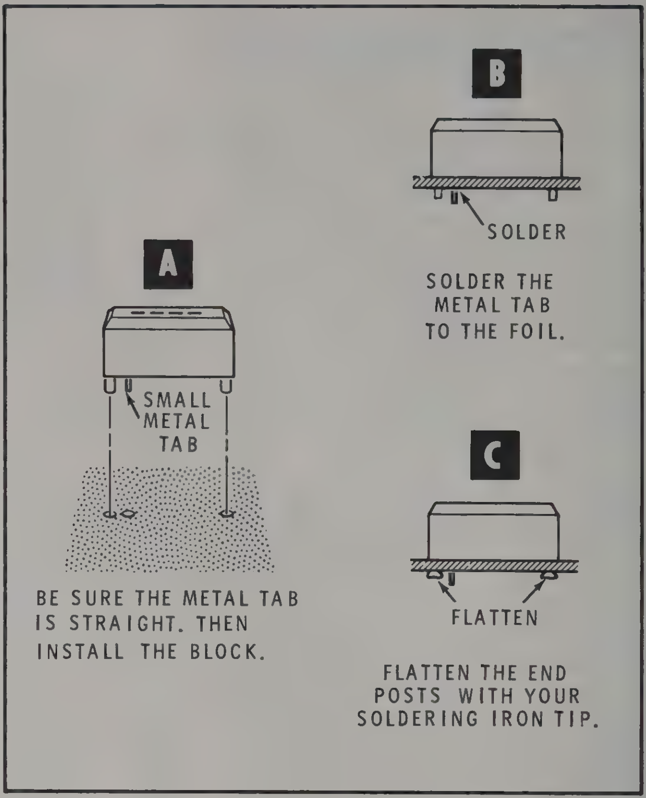
NOTE: In some of the following steps, you will solder to large areas of foil. These connections will require more heat. Hold the soldering iron against the connection until the solder flows smoothly onto the foil.



Detail 1-7A

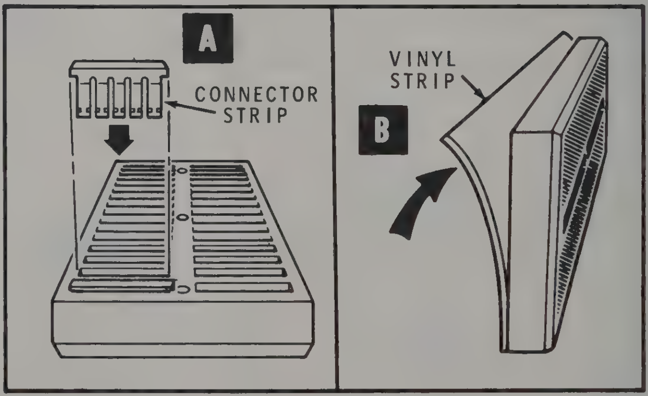
(/) Refer to Parts A, B, and C of Detail 1-7B and install connector blocks at the fifteen indicated locations. Make sure the connector block metal tabs are straight and that they go into their circuit board mounting holes as you press the connector blocks into place. Be careful not to break off the small metal tab.

(/) Refer to Part A of Detail 1-7C and install the connector strips, supplied with the breadboarding socket, into the large connector block. You may have some connector strips left over.

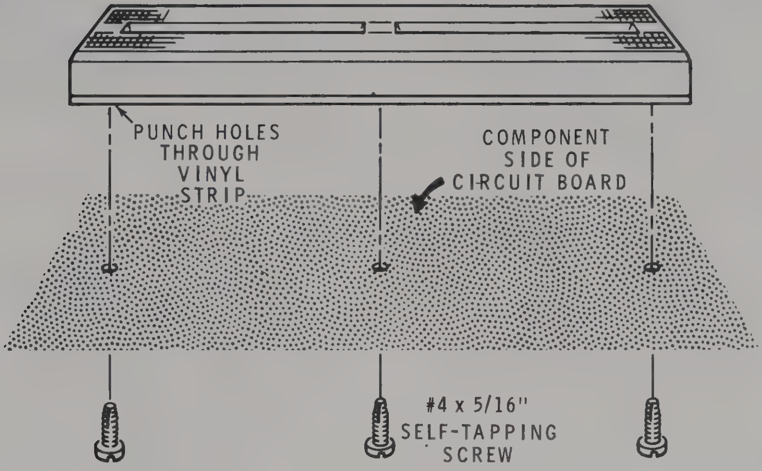

B
SOLDER
SOLDER THE METAL TAB TO THE FOIL.
A
SMALL METAL TAB
BE SURE THE METAL TAB IS STRAIGHT. THEN INSTALL THE BLOCK.
C
FLATTEN
FLATTEN THE END POSTS WITH YOUR SOLDERING IRON TIP.

Detail 1-7B

(/) Refer to Part B of Detail 1-7C. Then remove the paper backing from the vinyl strip supplied with the breadboarding socket. Line up the long edges of the strip and socket as shown, and press the sticky side of the cushion strip against the socket.



Detail 1-7C


PUNCH HOLES THROUGH VINYL STRIP
COMPONENT SIDE OF CIRCUIT BOARD
#4 x 5/16" SELF-TAPPING SCREW

Detail 1-7D

(✓) Refer to Detail 1-7D and use the tip of your phillips head screwdriver to punch through the vinyl strip at the three breadboarding socket mounting holes. Then mount the breadboarding socket to the circuit board with three #4 × 5/16" self-tapping screws as shown.

(✓) R104: Refer to Detail 1-7E and mount a 3000 Ω (3 K) control (#10-1053) to the circuit board at R104 with a control lockwasher, a control flat washer, and a control nut. Make sure you position the lugs as shown.

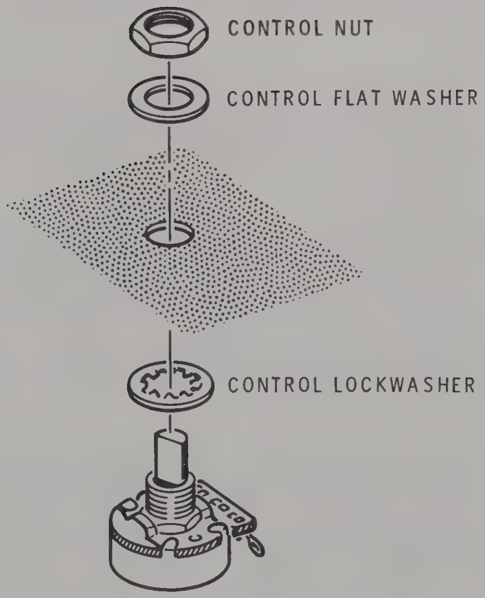
Mount each of the controls in a similar manner at the following circuit board locations using the control hardware. Position the control lugs as shown:

(✓) R114: 3000 Ω (3 K) control (#10-1053) at R114.

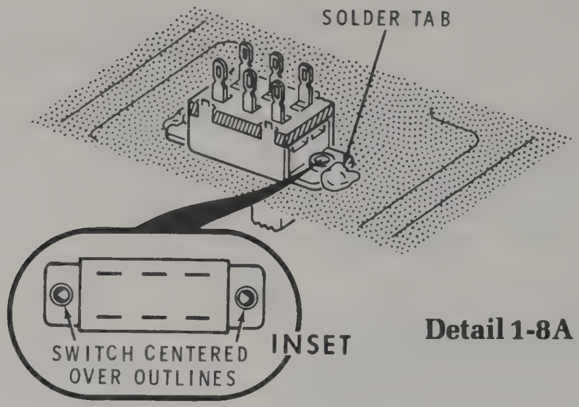
(✓) R122: 1000 Ω (1 K) control (#10-1054) at R122.

(✓) R121: 100 kΩ control (#10-1055) at R121.

(✓) R5/R9: 200 kΩ/5 kΩ dual control (#12-184) at R5/R9.



Detail 1-7E



Detail 1-8A

Refer to Pictorial 1-8 (Illustration Booklet, Page 4) for the following steps.

(/) Turn the circuit board over with the foil side facing up and position it as shown in the Pictorial.

(/) SW1: Refer to Detail 1-8A and position the slide switch so the switch tab holes are centered over the foil patterns as shown in the inset drawing. Solder one tab of the DPDT slide switch to the foil and operate the switch to make sure it does not rub against the circuit board. Then solder the other switch tab to the foil.

NOTES:

1. When a bare wire is called for in the following steps, first cut a yellow wire to the indicated length, and then remove all of the insulation from the wire.

2. When you solder a wire (or lead) to the foil in the following steps, lay the wire end flat on the foil and solder it to the foil. If the wire tries to spring up off the foil, hold it down with the blade of a screwdriver until the solder cools.

3. To prepare solid wires, as in the following steps, cut the wire to the indicated length and remove 1/4" of insulation from each end.

(/) Prepare the following wires:

Two 1" bare
Four 1-3/4" yellow

NOTE: In the following steps, (NS) means not to solder because other wires will be added later. "S-" with a number following it, such as (S-3), means to solder the connection. The number three tells you that there are three wires and/or leads in the connection. After you solder a wire or a group of wires to the circuit board foil, always cut off the excess wire or lead lengths.

Connect the prepared wires to control R122 as follows:

(/) 1" bare wire from lug 2 (S-1) to foil E (S-1).

(/) 1-3/4" yellow wire from lug 1 (S-1) to foil D (S-1).

(/) 1-3/4" yellow wire from lug 3 (S-1) to foil F (S-1).

Connect the remaining prepared wires to control R121 as follows:

(/) 1" bare wire from lug 2 (S-1) to foil B (S-1).

(/) 1-3/4" yellow wire from lug 1 (S-1) to foil A (S-1).

(/) 1-3/4" yellow wire from lug 3 (S-1) to foil C (S-1).

(/) Prepare the following yellow wires:

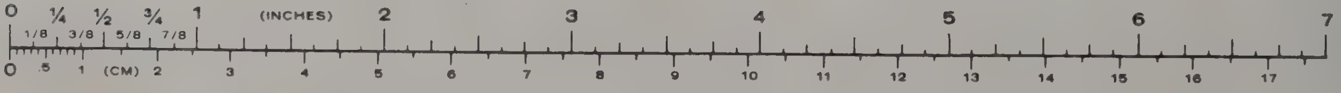
Three 1"
One 2-1/2"
One 2-5/8"
One 1-1/2"

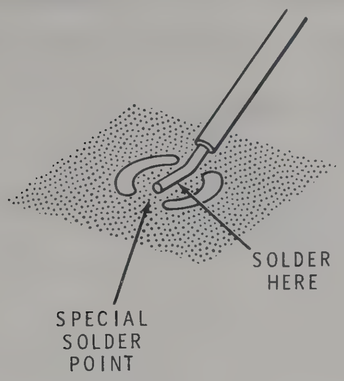
Connect the prepared yellow wires as follows:

(/) 1" yellow wire from control R104 lug 1 (S-1) to foil L (S-1).

(/) 1" yellow wire from control R104 lug 2 (S-1) to foil M (S-1).

(/) 2-1/2" yellow wire from control R104 lug 3 (NS) to control R114 lug 3 (S-1). Position this wire down on the circuit board.





Detail 1-8B

NOTE: On some large areas of the circuit board foil, special solder points have been prepared to make soldering easier. Portions of foil have been etched away so solder connections will not require as much heat. Use these special solder points as shown in Detail 1-8B whenever you are directed to do so in a step.

(✓) 2-5/8" yellow wire from control R104 lug 3 (S-2) to special solder point N (S-1).

(✓) 1" yellow wire from control R114 lug 1 (S-1) to foil P (S-1).

(✓) 1-1/2" yellow wire from control R114 lug 2 (S-1) to foil Q (S-1).

(✓) Prepare a 2-3/4" and a 2-1/4" yellow wire.

(✓) Connect the 2-3/4" yellow wire from switch SW1 lug 2 (S-1) to foil S (S-1). Route the wire around the switch lugs as shown.

(✓) Connect the 2-1/4" yellow wire from switch SW1 lug 5 (S-1) to foil R (S-1).

(✓) Cut four 1/2" pieces of small sleeving.

(✓) C3: Slide a 1/2" piece of small sleeving over one lead of .02 μF Mylar capacitor. Connect the lead with the sleeving to switch SW1 lug 1 (NS). Position the other lead against foil T (NS).

(✓) C4: Slide a 1/2" piece of small sleeving over one lead of the other .02 μF Mylar capacitor. Connect the lead with the sleeving to switch SW1 lug 4 (NS). Position the other lead against foil T (S-2).

(✓) C8: Connect a 15 pF ceramic capacitor between switch SW1 lug 1 (S-2) and lug 4 (S-2).

(✓) C6: Slide a 1/2" piece of small sleeving over one lead of a .0022 μF Mylar capacitor. Connect the lead with the sleeving to switch SW1 lug 3 (S-1). Position the other lead against foil U (NS).

(✓) C5: Slide a 1/2" piece of small sleeving over one lead of the other .0022 μF Mylar capacitor. Connect the lead with the sleeving to switch SW1 lug 6 (S-1). Position the other lead against foil U (S-2).

(✓) Prepare a 1-1/2" yellow wire.

(✓) Connect the 1-1/2" yellow wire from dual control R5/R9 lug 4 (S-1) to the corner at foil X (S-1).

(✓) R8: Connect a 47 Ω (yel-viol-blk) resistor from dual control R5/R9 lug 5 (S-1) to foil W (NS). Center the resistor body between the lug and the foil.

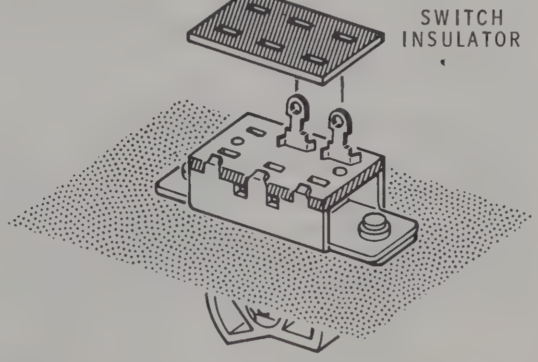
(✓) R6: Connect a 33 kΩ (org-org-org) resistor to dual control R5/R9 between lugs 1 (NS) and 2 (NS).

(✓) R7: Connect a 10 kΩ (brn-blk-org) resistor from dual control R5/R9 lug 1 (S-2) to foil W (S-2). Center the resistor body between the lug and the foil.

(✓) Prepare a 1-3/4" yellow wire.

(✓) Connect the 1-3/4" yellow wire from control R5/R9 lug 2 (S-2) to foil V (S-1).

(✓) Refer to Detail 1-8C and position the switch insulator down over the lugs of switch SW101.



Detail 1-8C

(/) Prepare two 12" red stranded wires. To prepare a **stranded** wire cut it to the indicated length and remove 1/4" of insulation from each end. Twist the bare wire strands at each end tightly together; then apply a **small** amount of solder to hold the strands in place.

(/) Cut two 3/4" pieces of heat-shrinkable sleeving.

(/) Slide a 3/4" piece of sleeving over one end of each of the 12" red stranded wires. Keep the sleeving at least 1" behind the bare wire end so you can connect the wires in the following steps.

(/) Connect the sleeving end of one 12" red stranded wire to switch SW101 lug 1 (S-1). Wrap the wire securely around the switch lug. You will connect the free end of this wire later.

(/) Connect the sleeving end of the other 12" red stranded wire to switch SW101 lug 2 (S-1). Wrap the wire securely around the switch lug. You will connect the free end of this wire later.

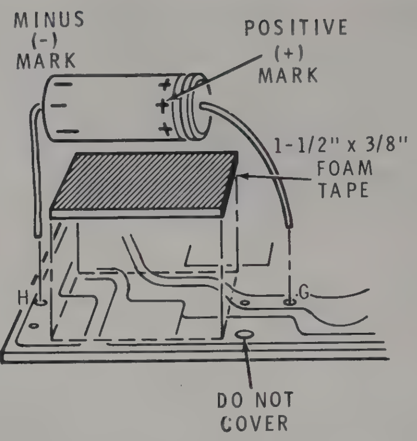
(/) Slide both lengths of heat-shrinkable sleeving on the 12" red stranded wires over lugs 1 and 2 of switch SW101. Then use the heat from a lighter, match, or hot soldering iron to shrink the sleeving against the lugs. Do not apply too much heat; otherwise, you may split the sleeving.

(/) Cut a 1-1/2" length of 5" × 3/4" foam tape.

(/) Cut the 3/4" width of the foam tape in half to make two 1-1/2" × 3/8" pieces.

(/) Refer to Detail 1-8D and remove the paper backing from **one side** of a 1-1/2" × 3/8" piece of foam tape. Apply the adhesive side of the tape between circuit board holes G and H as shown. Center the tape between the letters and do not cover the indicated large hole.

(/) Similarly, apply the other length of 1-1/2" × 3/8" foam tape between circuit board holes J and K. NOTE: The foam tape will cover the etched letters on this side of the circuit board. However, the letters are screened on the other (component) side of the circuit board for reference.



Detail 1-8D

NOTE: Before you install an electrolytic capacitor, look at it and identify the leads. One lead will have a positive (+) mark or a negative (−) mark near it. **Make sure** you install the positive lead and negative lead into their correct holes. Be careful; only the negative lead may be marked.

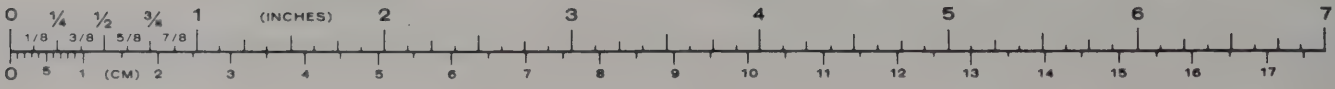
(/) C101: Refer to Detail 1-8D and remove the remaining paper backing from the foam tape between letters G and H.

(/) C101: Refer to Detail 1-8D and install a 1000 μF electrolytic capacitor over the foam tape with the positive (+) lead at hole G (S-1) and the negative (−) lead at hole H (S-1). Press the capacitor body firmly against the adhesive side of the foam tape to hold it in place.

(/) C111: Similarly, remove the remaining paper backing from the foam tape between letters J and K.

(/) Install the other 1000 μF electrolytic capacitor over the foam tape with the positive (+) lead at hole K (S-1) and the negative (−) lead at hole J (S-1). Press the capacitor body firmly against the adhesive side of the tape to hold it in place.

(/) Cut off the excess electrolytic capacitor lead lengths from the component side of the circuit board so they are even with the top edge.


0 ¼ ½ ¾ 1 (INCHES) 2 3 4 5 6 7
1/8 3/8 5/8 7/8
0 5 1 (CM) 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17

CIRCUIT BOARD CHECKOUT

Carefully inspect the circuit board for the following conditions.

(✓) Unsoldered connections.

(✓) Poor solder connections.

(✓) Solder bridges between foil patterns.

(✓) Protruding leads which could touch together.

(✓) Transistors and IC's for the proper **type** and **installation**.

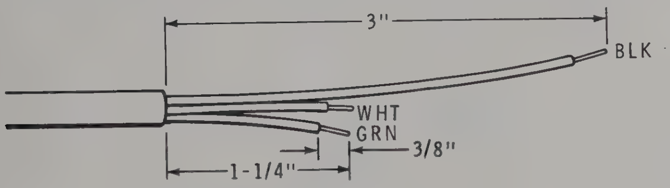
(✓) Electrolytic capacitors for the correct position of the positive (+) and negative (–) mark.

(✓) Diodes for the correct position of the banded end.

Set the circuit board aside temporarily.

CABINET ASSEMBLY

Refer to Pictorial 2-1 (Illustration Booklet, Page 5) for the following steps.

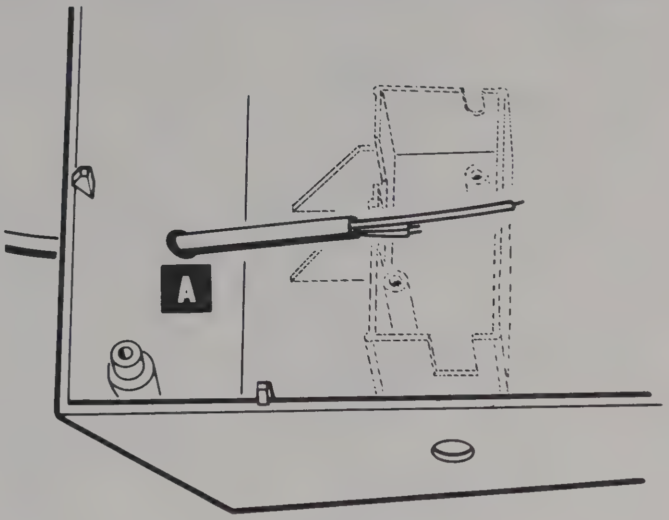


Detail 2-1A

(✓) Refer to Detail 2-1A and prepare the free end of the line cord as follows:

1. Carefully remove the outer insulation of the line cord for 3".

2. Cut the exposed white and green leads to a length of 1-1/4". Then remove 3/8" of insulation from the end of each lead.

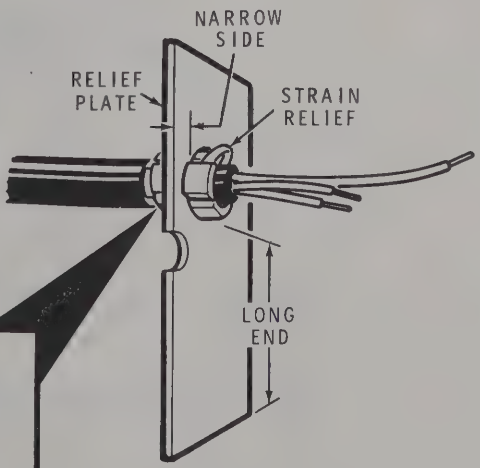


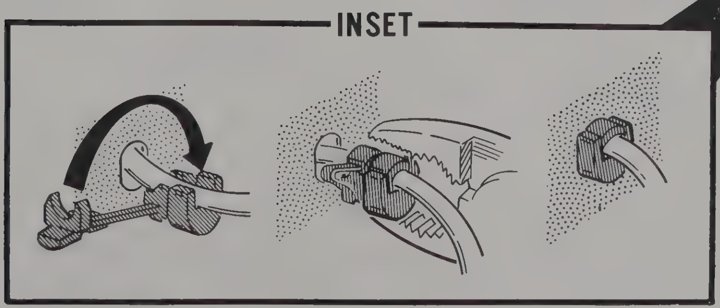
Detail 2-1B

3. Twist together the fine wire strands at the end of each lead. Then melt a small amount of solder onto the end of each lead to hold the fine strands together.

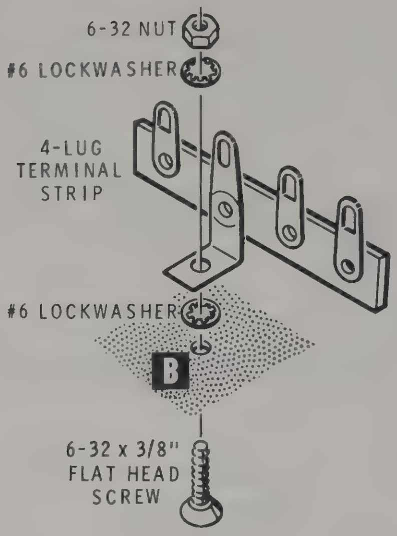
(✓) Refer to Detail 2-1B and push the end of the line cord through hole A (from the outside of the cabinet bottom).

(✓) Refer to Detail 2-1C and position the relief plate with the long end and the narrow side as shown. Insert the end of the line cord through the plate and install the strain relief on the line cord as shown in the inset drawing. Keep the outside insulation on the line cord just past the end of the strain relief.





Detail 2-1C



Detail 2-1D

(✓) Refer to Detail 2-1D and mount the terminal strip at B in the cabinet bottom with a 6-32 × 3/8" flat head screw, two #6 lockwashers, and a 6-32 nut. Use the plastic nut starter to start the nut on the screw.

NOTE: In the following steps, make mechanically secure connections. To make a connection mechanically secure, wrap the lead or wire ends around the terminal strip lugs before you solder them. See the inset drawing.

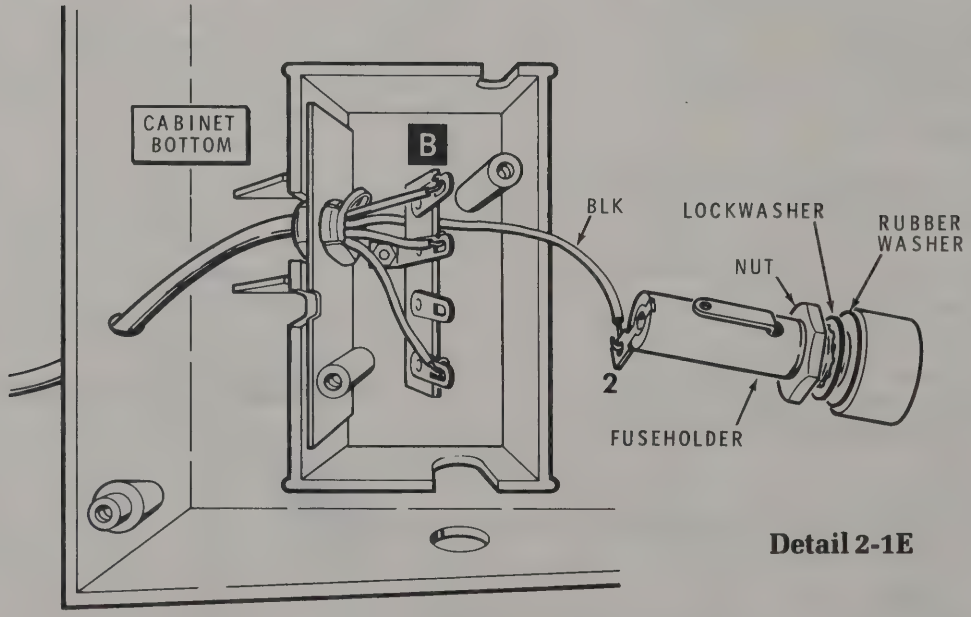
(✓) Slide the line cord relief plate into place in the cabinet bottom. Make sure the plate is against the wall of the cabinet.

(✓) Connect the white line cord lead to terminal strip B lug 1 (NS).

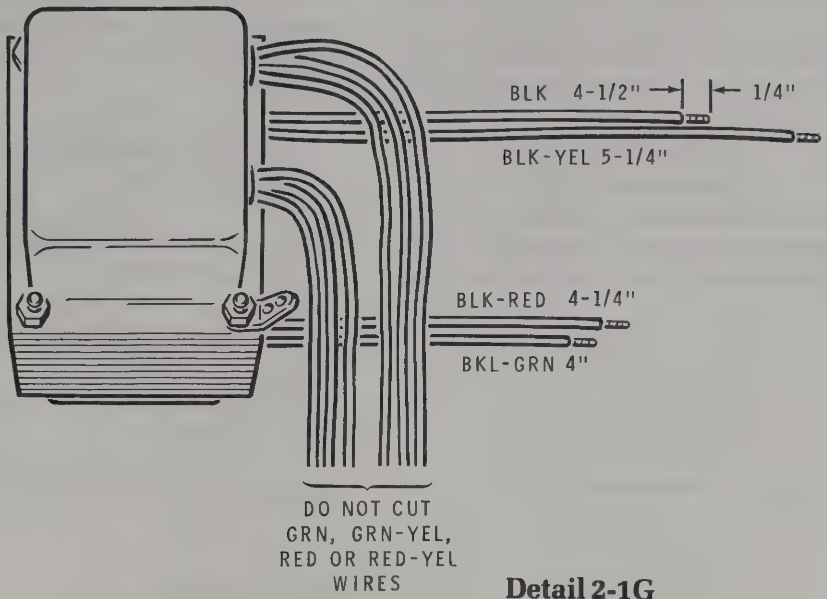
(✓) Connect the green line cord lead to terminal strip B lug 2 (NS).

(✓) Refer to Detail 2-1E and slide the rubber washer, lockwasher, and nut onto the fuseholder. Turn the nut onto the fuseholder threads for approximately three turns, but do not mount it yet.

(✓) Refer again to Detail 2-1E and position the fuseholder near terminal strip B in the cabinet bottom. Route the black line cord lead under terminal strip B and connect it to fuseholder lug 2 (S-1). Be sure to connect the lead to the side of the lug as shown.

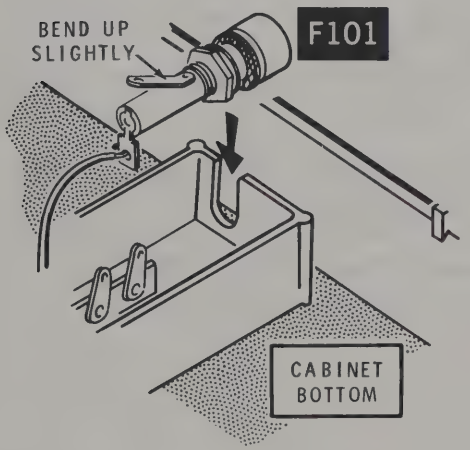


Detail 2-1E



Detail 2-1G

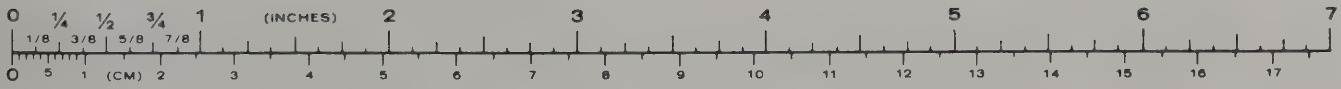
(✓) Refer to Detail 2-1F and mount the fuseholder at F101 as shown. Keep the rubber washer on the side of the cabinet against the fuseholder shoulder.



Detail 2-1F

( ) Refer to Detail 2-1G and prepare the transformer leads as shown. Measure the leads from where they come out of the transformer. Prepare the lead ends, if necessary.

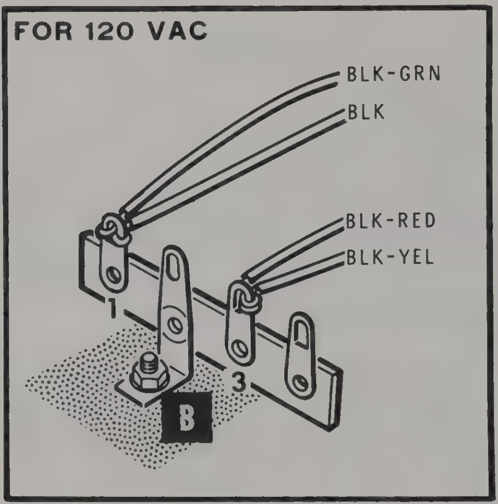
( ) T101: Refer to Pictorial 2-1 and mount the transformer (with the red and green leads up) with two #6 × 1-1/8" self-tapping screws.


0 ¼ ½ ¾ 1 (INCHES) 2 3 4 5 6 7
1/8 3/8 5/8 7/8
0 5 1 (CM) 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17

ALTERNATE LINE VOLTAGE WIRING

Two sets of line voltage wiring instructions are given below, one for 120 VAC and the other for 240 VAC. In the United States, 120 VAC is most common. USE ONLY THE INSTRUCTIONS THAT AGREE WITH THE LINE VOLTAGE IN YOUR AREA.

NOTE: The plug on the power cord for this kit is for standard 120 VAC outlets in most of North America. For 240 VAC operation in other countries, cut off and replace this plug with a permanent plug that matches your 240 VAC receptacle.



Detail 2-1H

FOR 120 VAC

Refer to Detail 2-1H for the following steps. In these steps, make the connections to terminal strip B mechanically secure. Connect the transformer leads as follows:

(✓) Twist the black-red and black-yellow leads together.

(✓) Connect the black-red and black-yellow leads to lug 3 (NS).

(✓) Twist the black and black-green leads together.

(✓) Connect the black-green and black leads to lug 1 (S-3).

Proceed to "Final Wiring" on Page 25.

FOR 240 VAC

Refer to Detail 2-1J for the following steps. In these steps, make connections to terminal strip B mechanically secure. Connect the transformer leads as follows:

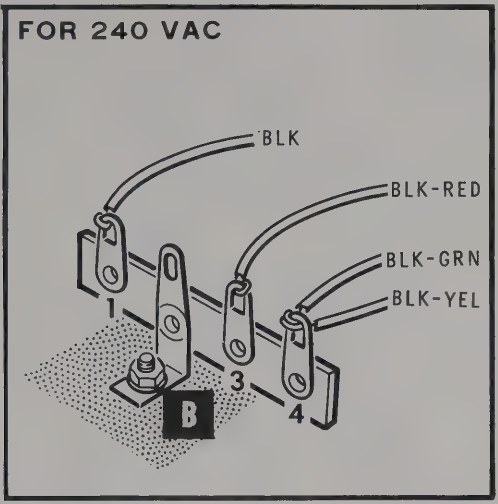
( ) Connect the black lead to lug 1 (S-2).

( ) Connect the black-red lead to lug 3 (NS).

( ) Twist the black-yellow and black-green leads together.

( ) Connect the black-yellow and black-green leads to lug 4 (S-2).

Proceed to "Final Wiring" on Page 25.



Detail 2-1J

FINAL WIRING

Refer to Pictorial 2-1 and connect the remaining transformer leads to the foil side of the circuit board as follows. When you solder these leads to the foil, position the edge of the insulation 1/16" from the foil to make soldering easier. See inset drawing #1 in the Pictorial:

(✓) Twist the three red wires together.

(✓) Connect the red-yellow lead to hole CC (S-1).

(✓) Connect either red lead to hole AA (S-1).

(✓) Connect the other red lead to hole BB (S-1).

(✓) Twist the three green leads together.

(✓) Connect the green-yellow lead to hole FF (S-1).

(✓) Connect either green lead to hole DD (S-1).

(✓) Connect the other green lead to hole EE (S-1).

(✓) Cut off the excess lead lengths from the component side of the circuit board.

(✓) Twist the two red wires together coming from switch SW101.

In the following two steps, make mechanically secure connections. See inset drawing #2.

(✓) Connect either red wire coming from switch SW101 to terminal strip B lug 3(S-3). NOTE: This connection is (S-2) if you wired your kit to operate on 240 VAC. Connect the other red wire to fuseholder F101 lug 1 (S-1). Route the twisted red wires through the indicated fuse compartment slot.

(✓) Prepare the following green stranded wires:

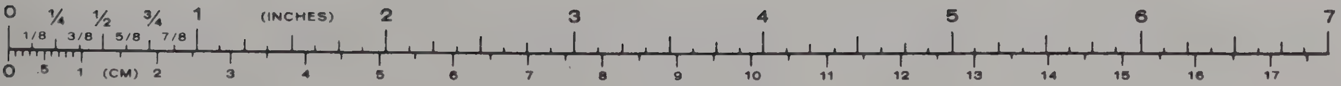
3-3/4"
10"

NOTE: The following two steps are for a solder lug that has two holes. If the solder lug on the transformer has one hole, install both wires before you solder the connection.

Connect the green stranded wires as follows:

(✓) 3-3/4" green stranded wire from terminal strip B lug 2 (S-2) to either hole in the transformer solder lug (S-1). Do not cover the other hole with solder. NOTE: The remaining solder lug hole will have its own solder step.

(✓) 10" green stranded wire from the remaining hole in the transformer solder lug (S-1) to the indicated circuit board foil location (S-1).

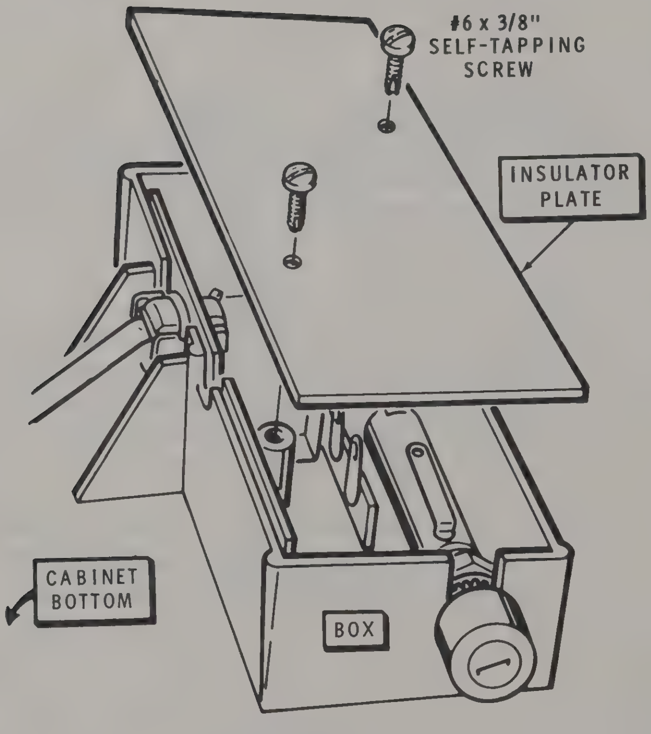


Refer to Pictorial 2-2 for the following steps.

(✓) Refer to Detail 2-2A and route the leads and wires in the cabinet bottom terminal strip compartment as shown.

(✓) Mount the insulator plate to the terminal strip compartment with two #6 × 3/8" self-tapping screws. Do not pinch any of the wiring between the plate and the cabinet.

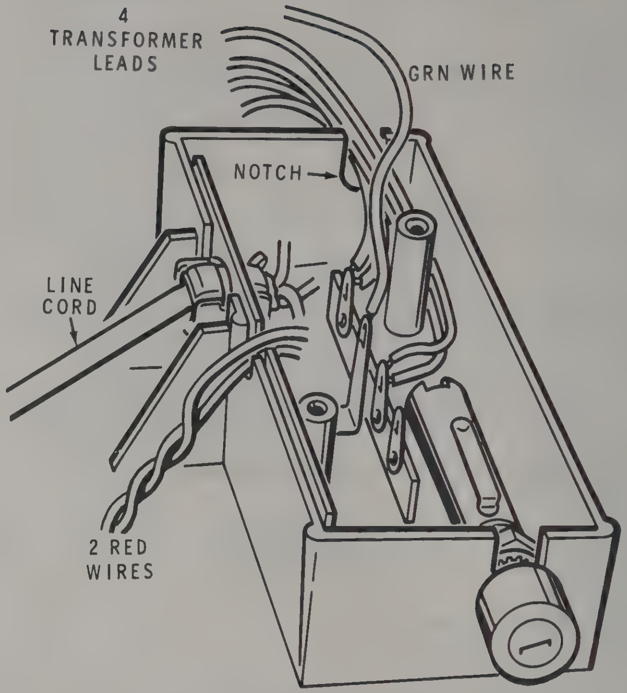
(✓) F101: If necessary, remove the fuseholder cap from the fuseholder by twisting it counterclockwise with a screwdriver. Then install the 1/4-ampere slow-blow fuse and replace the cap. Do not overtighten the cap.



PICTORIAL 2-2

KNOB INSTALLATION

Refer to Pictorial 2-3 (Illustration Booklet, Page 6) for the following steps.



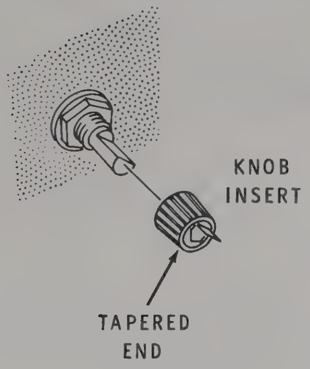
Detail 2-2A

( ) Position the circuit board with the component side facing up as shown.

NOTE: Refer to Detail 2-3A and note that the knob bushing is tapered. When you place one of these bushings on a control shaft, make sure the smaller (tapered) end faces out or the knob will not slide onto the bushing. If you are not sure which end is the smaller, roll the bushing across a flat surface; the bushing will gradually turn toward the smaller end.

( ) Refer to Detail 2-3A and push knob inserts onto controls R104, R114, R5/R9, R122, and R121.

( ) Turn these controls fully counterclockwise.



Detail 2-3A

( ) Refer to Detail 2-3B and install a knob onto the knob insert on control R104 as instructed in the Detail. Support the back of the circuit board with your fingers, and position the knob pointer toward 1 on top of the circuit board.

Similarly, install a knob on each of the following controls. Position the knob pointers as shown in the Pictorial:

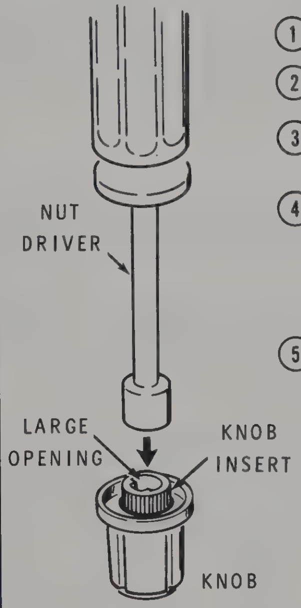
( ) R114.

( ) R5/R9.

( ) R122.

( ) R121.

This completes the assembly of your Heathkit Electronic Design Experimenter. Carefully inspect all connections for loose wires or unsoldered connections. Remove any wire clippings or solder splashes. Then proceed to "Test And Adjustments" on Page 28.



① LINE UP THE POINTER AS CALLED OUT IN THE STEP.

② PUSH THE KNOB PART WAY ONTO THE INSERT.

③ CAREFULLY REMOVE BOTH THE INSERT AND THE KNOB. DO NOT ALLOW THE KNOB TO COME OFF THE INSERT.

④ PLACE THE KNOB ON A TABLE OR OTHER FIRM SURFACE. PLACE A SOFT CLOTH UNDER THE KNOB TO PREVENT IT FROM BEING MARRED. THEN USE A NUTDRIVER OR LARGE SCREWDRIVER AND DRIVE THE INSERT INTO THE KNOB.

⑤ REPLACE THE KNOB ON THE CONTROL FROM WHICH IT WAS REMOVED.

Detail 2-3B

TEST AND ADJUSTMENTS

The purpose of this section of the Manual is to make sure your kit operates properly.

Refer to Pictorial 3-1 (Illustration Booklet, Page 7) for the following steps.

( ) Position the circuit board and cabinet bottom assembly as shown.

( ) Place a piece of cardboard (from your shipping carton) under switch SW101 so the switch lugs cannot touch your work surface.

CAUTION: In the following steps, do not touch the area marked "High Voltage Area." 120 VAC is present at these locations when the line cord is plugged into an AC outlet.

NOTE: If you do not get the proper results in the following steps, unplug the line cord and proceed to "In Case of Difficulty" on Page 31.

( ) Plug in the line cord plug. Indicator V101 should light. (If the indicator does not light, push switch SW101 to the other position.)

If you have an oscilloscope and/or a frequency counter, perform the following steps under "Frequency Generator Test." Otherwise, skip these steps and proceed to "Power Supply Test."

FREQUENCY GENERATOR TEST

( ) Plug the oscilloscope (and/or frequency counter) into an AC outlet and turn it on.

( ) Prepare two 2″ lengths of leftover solid wire.

( ) Press one 2″ bare wire end into one of the SINE connector block holes. (See the inset drawing.) Connect the oscilloscope's (or frequency counter's) vertical input to the free end of this wire. Press the other 2″ wire into one of the GND connector block holes and connect the common lead to the free end of this wire.

( ) Set the Experimenter's RANGE switch (SW1) to LOW.

( ) With the FREQ control (R5/R9) set fully counterclockwise, you should see a sine wave on your oscilloscope, or read 200 Hz (±20%) on the frequency counter's display.

( ) Advance the FREQ control to its fully clockwise position and the frequency should increase to its maximum level of 2 kHZ.

( ) Set the RANGE switch to HIGH and repeat the previous three steps. However, now the output levels should be from 2 kHz to 20 kHz (±20%).

( ) Connect the Oscilloscope (or counter) positive input lead and wire to the SQUARE wave connector block and repeat the previous four steps. You should see a square wave on your oscilloscope for these steps.

( ) Disconnect the oscilloscope (or the frequency counter) leads and 2″ wires from the terminal blocks. Set the wires aside for the next test.

This completes the "Frequency Generator Test." Proceed to "Power Supply Tests."

POWER SUPPLY TESTS

NOTE: If you do not have a voltmeter, skip this section and proceed to "Final Assembly."

Refer to Pictorial 3-1 (Illustration Booklet, Page 7) for the following tests.

( ) Set your voltmeter to the 15 volt DC range. Then connect the common lead to the NEG (−) connector block and the other meter lead to the GND connector block. Use the 2″ solid wires you set aside after the last test to connect the meter leads to the connector blocks.

( ) Adjust the negative (−) power supply control (R114) from 1 to 15. The voltmeter should indicate from approximately 1 volt to 15 volts DC.

( ) Connect the common voltmeter lead to the GND connector block. Connect the other voltmeter lead to the POS (+) connector block.

( ) Adjust the positive (+) VOLTAGE control (R104) from 1 to 15. The voltmeter should indicate approximately 1 volt to 15 volts DC.

( ) Disconnect the voltmeter leads and the 2″ wires from the connector blocks.

( ) Turn the Experimenter off.

( ) Insert one of the 2″ wire ends into LINE FREQ connector block 1 and the other 2″ wire end into connector block 2. Connect the voltmeter leads between these two wires.

( ) Set your voltmeter to measure 30 volts AC.

( ) Turn the Experimenter on.

( ) The meter should indicate approximately 15 volts AC.

( ) Being careful not to touch the lead at terminal block 2, move the wire and lead from connector block 1 to connector block 3. The meter should indicate 15 volts AC.

( ) Being careful not to touch the lead at terminal block 3, move the wire and lead from terminal block 2 to terminal block 1. The meter should indicate 30 volts AC.

( ) Turn off the Experimenter and disconnect the line cord.

This completes the "Power Supply Tests." Proceed to "Final Assembly."

FINAL ASSEMBLY

Refer to Pictorial 4-1 (Illustration Booklet, Page 8) for the following steps.

( ) Remove the protective backing from the nameplate label and press the label onto the cabinet top as shown.

( ) Press the plastic bushing into the indicated cabinet top hole so it seats around the indicator.

Refer to Pictorial 4-2 (Illustration Booklet, Page 8) for the following steps.

( ) Position the cabinet top and bottom assemblies as shown.

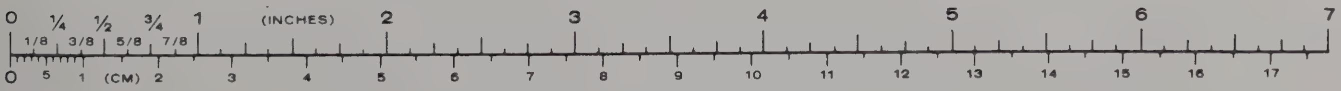
( ) Refer to inset drawing #1 and firmly press a #6 brass insert into post D in the cabinet bottom. Push it in as far as it will go.

( ) Press a #6 brass insert into post E in the cabinet bottom.

( ) While you hold the shoulder of one of the #6 brass inserts with a pair of long-nosed pliers, turn a 6-32 × 1/4″ screw into the brass insert until it anchors into the post solidly. Remove the screw and anchor the other #6 brass insert to its post. Then remove the screw and set it aside.

( ) Remove the protective backing from the insulator paper and press the paper into position near switch SW101 as shown. Make sure you align the mounting holes properly.

( ) Refer to Detail 4-2A and insert LED V101 on the circuit board through its cabinet top mounting hole. Then secure the circuit board to the cabinet top with seven #6 × 3/8″ self-tapping screws.



( ) Refer to inset drawing #2 and mount a cable clamp around the red wires coming from switch SW101. Secure the cable clamp and the circuit board to the cabinet top with a #8 flat washer and a #6 × 1/2" self-tapping screw.

( ) Refer to Pictorial 4-3 and mount the cabinet top to the cabinet bottom with two 6-32 × 1/4" screws and eight #6 × 5/8" self-tapping flat head screws. Make sure you do not pinch any wiring between the cabinet halves.

Refer to Pictorial 4-4 (Illustration Booklet, Page 9) for the following steps.

( ) Position the cabinet upside-down as shown.

NOTE: Before you install any of the labels in the following steps, clean the area thoroughly with alcohol.

( ) Remove the protective backing from the Caution label and press the label to the cabinet bottom as shown. Install it so the printing is upside down.

( ) Similarly, install the blue and white label at the indicated cabinet bottom location. Be sure to refer to the numbers on this label in any correspondence you have with the Heath Company about this kit.

( ) Similarly, install the FCC label at the indicated cabinet bottom location.

( ) Install a foot in the smooth areas at each of the four corners of the cabinet bottom as shown. First remove the protective backing from the foot, then press the foot into place.

This completes the "Step-By-Step Assembly" of your Experimenter. You can use the remaining wire for your experiments. Proceed to "Operation and Applications."

OPERATION AND APPLICATIONS

Refer to Pictorial 5-1 (Illustration Booklet, Page 10) for a brief description of each control function.

CONNECTOR BLOCK

The connector blocks are designed to accept up to #20 (.032") solid wire and most common-sized component leads. The four connectors in the small connector blocks are internally connected together. Also, each vertical row of five connectors in the breadboarding socket are connected together as shown in Pictorial 5-1. Thus, you can build simple or complex circuits without making solder connections.

The Experimenter not only supplies positive (+) and negative (−) DC voltages, but also 15 and 30 volts AC, and both sine and square wave signals from 200 Hz to 20 kHz. Use the 1 kΩ and 100 kΩ controls whenever you need variable resistors or voltage dividers.

Experiments #1 and #2 (Illustration Booklet, Page 11) are two examples of typical experiments. The first experiment uses transistors, and the second uses an integrated circuit. The breadboarding socket is designed to accommodate integrated circuits and the IC puller supplied in your kit. This IC puller fits down into the center channel of the breadboarding socket to gently and easily lift the IC out.

IN CASE OF DIFFICULTY

Begin your search for any trouble that occurs after assembly by carefully following the steps listed below in the "Visual Checks." After the "Visual Checks" are completed, if necessary, refer to the "Troubleshooting Chart."

NOTE: Refer to the "Circuit Board X-Ray View" (Illustration Booklet, Page 12) for the physical location of parts on the circuit board and to check for possible solder bridges.

VISUAL CHECKS

1. Check to be sure that all diodes, transistors, and integrated circuits are in their proper locations. Make sure each lead is connected to the proper point. Make sure that each diode band is positioned above the band printed on the circuit board.

2. About 90% of the kits that are returned to the Heath Company for repair do not function properly due to poor connections and soldering. Therefore, you can eliminate many troubles by reheating all connections to make sure they are soldered as described in the "Soldering" section of the "Assembly Notes" and on Page 10. Since some of the foil patterns are very small and close together, make sure there are no solder bridges between them. If there is any question of a foil bridge, compare the circuit board foil with the foil pattern on the "Circuit Board X-Ray View."

3. Check the values of the parts. Be sure in each step that the proper part has been wired into the circuit, as shown in the Pictorial diagrams. It would be easy, for instance, to install a 2.2 Ω (red-red-gold) resistor where a 220 Ω (red-red-brn) resistor should have been installed.

4. Check for bits of solder, wire ends, or other foreign matter which may be lodged on, or near, the circuit board.

5. Look on the underside of the circuit board to be sure all leads have been cut off and that none are bent over and touching one another.

6. A review of the "Circuit Description" may also help you to determine the area or section of the trouble.

If you still cannot locate the trouble after completing the "Visual Checks," and a voltmeter is available, check voltage readings against those shown on the Schematic Diagram (Illustration Booklet, Page 13). Read the "Precautions for Troubleshooting" before you make any measurements. NOTE: All voltage readings were taken with a high impedance voltmeter. Voltages may vary ±20%.

NOTE: In an extreme case where you are unable to resolve a difficulty, refer to the "Customer Service" information inside the rear cover of the Manual. Your Warranty is located inside the front cover of the Manual.

PRECAUTIONS FOR TROUBLESHOOTING

1. Be cautious when you test diodes, transistors, or integrated circuits. Although they have almost unlimited life when used properly, they are sensitive to excessive voltage or current. Some ohmmeters can apply over 1.5 volts and currents which exceed 100 mA. Use ohm range settings of R × 10 or higher.

2. Be sure you do not short any terminals to ground when you make voltage measurements. If the probe should slip, for example, and short across component leads or voltage sources, it is very likely to cause damage to one or more transistors, diodes, or integrated circuits.

CHECKING TRANSISTORS AND DIODES

Transistors

To check a transistor accurately, you should use a transistor tester. However, if one is not available, you can use an ohmmeter to determine the general condition of any one of the transistors in this kit. The ohmmeter you use must have at least 1 volt DC at the probe tip to exceed the threshold of the diode junctions in the transistor you are testing. Most vacuum tube voltmeters meet this requirement.

To check a transistor with an ohmmeter, proceed as follows:

1. Carefully remove the transistor from the circuit.
2. Set the ohmmeter to the R × 100 range.
3. Connect one of the ohmmeter test leads to the base (B) of the transistor. Touch the other meter lead to the emitter (E) and then to the collector (C). Both readings should be the same, but may be either high or low. If one reading is high and the other low, the transistor should be replaced. (Use the "Semiconductor Identification Chart" on Page 36 to identify the transistor leads.)
4. Interchange the test leads and repeat step 3.

NOTE: In the unusual case when the readings are all low, or all high, no matter which ohmmeter lead is connected to the base, the transistor should be replaced.

Diodes

To check a diode, unsolder one end from the circuit board, pull the lead up and out of the circuit board hole, and proceed as follows:

1. Set the ohmmeter to the R × 1000 range.
2. Connect one of the ohmmeter test leads to the lead at the cathode (banded) end of the diode. Connect the other test lead to the other diode lead. Note the meter reading. Then interchange the meter leads and take another reading. One reading should be high and the other low (at least 10:1). If both readings are either high or low, the diode should be replaced.

Troubleshooting Chart

The following chart lists several conditions and possible causes of specific malfunctions. If a particular part is mentioned as a possible cause, check that part and other components connected to it to see that they are installed and/or wired correctly.

PROBLEM	POSSIBLE CAUSE
No output from either power supply.	1. Fuse F101. 2. Transformer T101. 3. Diode D101, D102, D103, or D104.
Unable to adjust positive voltage output — stays high.	1. Transistor Q101, Q102, or Q103.
Unable to adjust positive voltage output — stays low.	1. Transistor Q101 or Q104.
Unable to adjust negative voltage output — stays high.	1. Transistor Q111, Q112, or Q113.
Unable to adjust negative voltage output — voltage stays low.	1. Transistor Q111 or Q114.
No output from signal generator.	1. U1 or U2. 2. Transistors Q1 or Q2. 3. Connections at R5/R9.
Excessive distortion in signal generator output.	1. U1 or U2. 2. Transistors Q1 or Q2.

SPECIFICATIONS

POWER SUPPLIES

Positive Supply Output	1.2 to 15 volts DC, continuously variable.
Load Regulation	2%, no load to full load.
Current Output	250 mA with short circuit protection.
Negative Supply Output	−1.2 to −15 volts DC, continuously variable.
Load Regulation	2%, no load to full load.
Current Output	250 mA with short circuit protection.

FREQUENCY GENERATOR

Range Selector Switch	LOW: 200 − 2000 Hz (nominal), continuously variable. HIGH: 2000 Hz − 20 kHz (nominal), continuously variable.
Sine Wave Output.	1 volt rms from 600 ohms at less than 4% distortion.
Square Wave Output	15 volts peak-to-peak (+15 volts maximum; .1 volt minimum) with rise time less than 1 μs and nominal duty cycle of 30%.

60 Hz SINE WAVE OUTPUT

Volts	15 and 30 volts rms.
Current	200 mA maximum.

GENERAL

Power Requirements	105-130 volts or 210-260 volts rms, 50/60 Hz @ 25 watts maximum.
Dimensions	12-1/8″ wide x 11-3/4″ deep x 3-1/2″ high (30.8 x 29.9 x 8.9 cm).
Weight	4.2 lbs. (1.9 kg).

The Heath Company reserves the right to discontinue products and to change specifications at any time without incurring any obligations to incorporate new features in products previously sold.

CIRCUIT DESCRIPTION

Refer to the Schematic Diagram (Illustration Booklet, Page 13) while you read this "Circuit Description."

FREQUENCY GENERATOR

The frequency generator consists of a pair of LM-301 operational amplifiers. IC U2 is the tuned oscillator, while IC U1 provides signal amplification and phase reversal for IC U2 to continue oscillation. The frequency is controlled by resistors R4, R8, R9, and capacitors C3 and C4 or C5 and C6. The output at pin 6 of IC U1 is 180° out of phase with the output at pin 6 of IC U2. Slide switch SW1 selects the low or high frequency ranges while resistor R9 is the tuning control. Control R5 is the clipping level adjustment and is in tandem with control R9. Zener diodes ZD1 and ZD2 provide a reference output to drive the tuned circuit and insure oscillation. Resistor R2 couples the out- of-phase signal back to the inverting input at pin 2 of IC U1. Diode D1 provides feed forward compensation to IC U2, which increases its bandwidth. Since the circuit does not require an AGC loop, the ocsillator starts quickly and reaches final amplitude within a few cycles.

The sine wave output at IC U2 is routed also to the junction of resistors R11 and R14. Resistors R14 and R15 provide a resistive divider for the sine wave output, which is routed to the external connector. Resistor R11 couples the sine wave to saturation amplifier transistors Q1 and Q2. Diode D2 provides base reference for transistor Q1. The output of transistor Q2 provides a variable frequency square wave which is routed to the square wave output connector.

POWER SUPPLY

Power for the oscillator is furnished by the (±)15 volt zener-regulated sources.

The power transformer can be wired for either 120 VAC or 240 VAC. The secondary voltage is rectified by diodes D101, D102, D103, and D104. It is filtered by capacitors C101, and C111 to provide filtered DC for the positive and negative power supplies. Because the power supplies are similar, only the positive supply will be discussed.

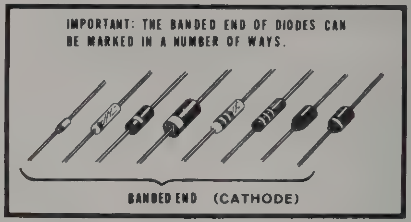
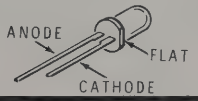
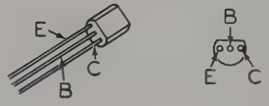
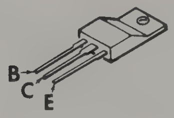
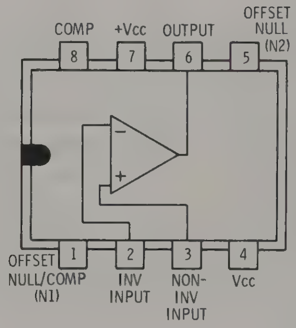
The positive 15 volt source is established by 15 volt zener diode ZD101. Resistor R102 limits the current to a safe value, and capacitor C103 adds filtering.

Control R104 selects the desired portion of the 15 volt reference. If the output of the power supply changes, transistor Q103 conducts more or less and, in turn, controls transistors Q101 and Q102 so the output remains constant.

If the output current becomes excessive, the voltage drop across resistor R105 turns transistor Q104 on. This reduces the voltage at the base of transistor Q101, which starts to turn transistor Q102 off and limit the output current to a safe level.

The remaining secondary of transformer T101 supplies 30 VAC directly to the front panel connectors. This secondary is center-tapped to also provide 15 VAC at the front panel connectors.

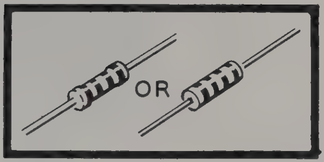
SEMICONDUCTOR IDENTIFICATION CHART

CIRCUIT COMP. NO.	HEATH PART NO.	MANUFACTURER'S NUMBER	BASE DIAGRAM
D1, D2, D106, D116	56-56	1N4149	 IMPORTANT: THE BANDED END OF DIODES CAN BE MARKED IN A NUMBER OF WAYS. BANDED END (CATHODE)
ZD1, ZD2	56-99	1N5223B	
ZD101, ZD111	56-620	1N4744A	
D101, D102, D103, D104	57-65	1N4002	
V101	412-640	LST5053	
Q111, Q113, Q114	417-235	2N4121	
Q1, Q3, Q101, Q103, Q104	417-801	MPSA20	
Q102	417-856	MJE5979	
Q112	417-857	MJE5976	
IC1, IC2	442-39	LM301	 COMP +Vcc OUTPUT OFFSET NULL (N2) 8 7 6 5 − + 1 2 3 4 OFFSET NULL/COMP (N1) INV INPUT NON-INV INPUT Vcc

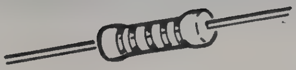
ILLUSTRATI

PARTS P

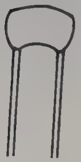
A1



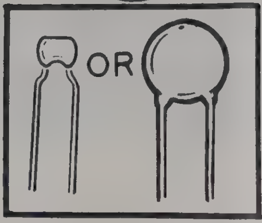
A2



B1

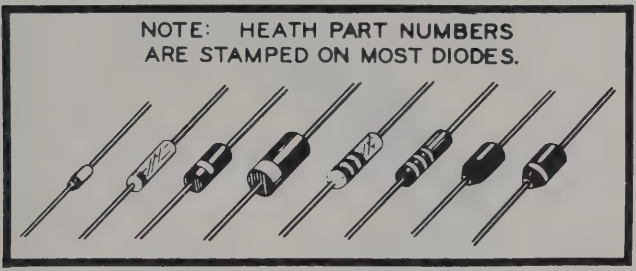


B2

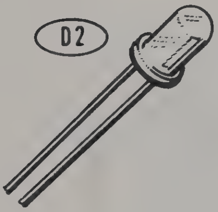


D1

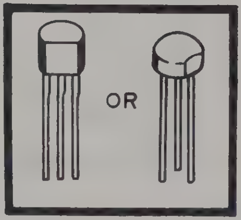
NOTE: HEATH PART NUMBERS
ARE STAMPED ON MOST DIODES.



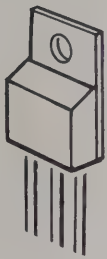
D2



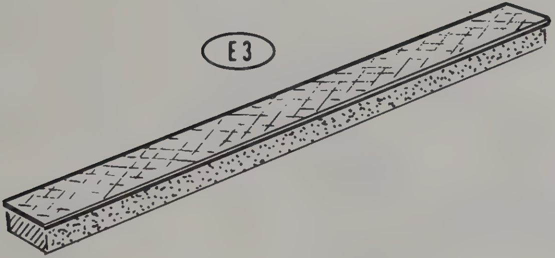
D3



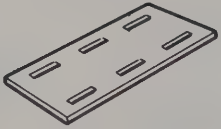
D4



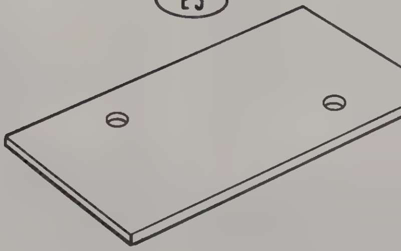
E3



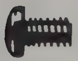
E4



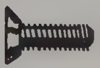
E5



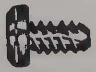
G1



G2



G3



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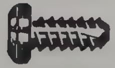

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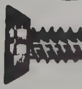
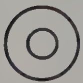


H1



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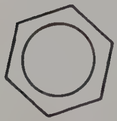

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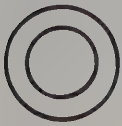

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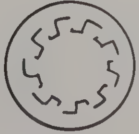


SEMICONDUCTOR IDENTIFICATION CHART

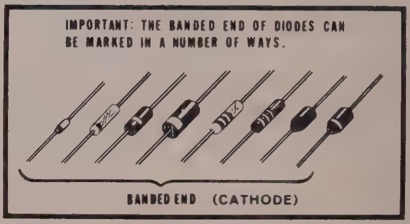
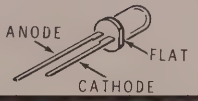
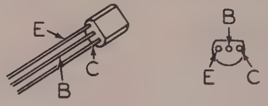
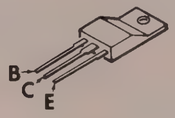
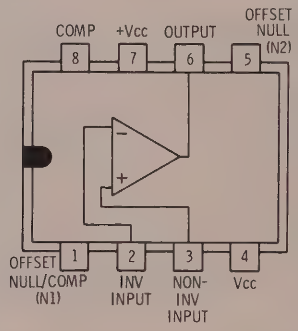
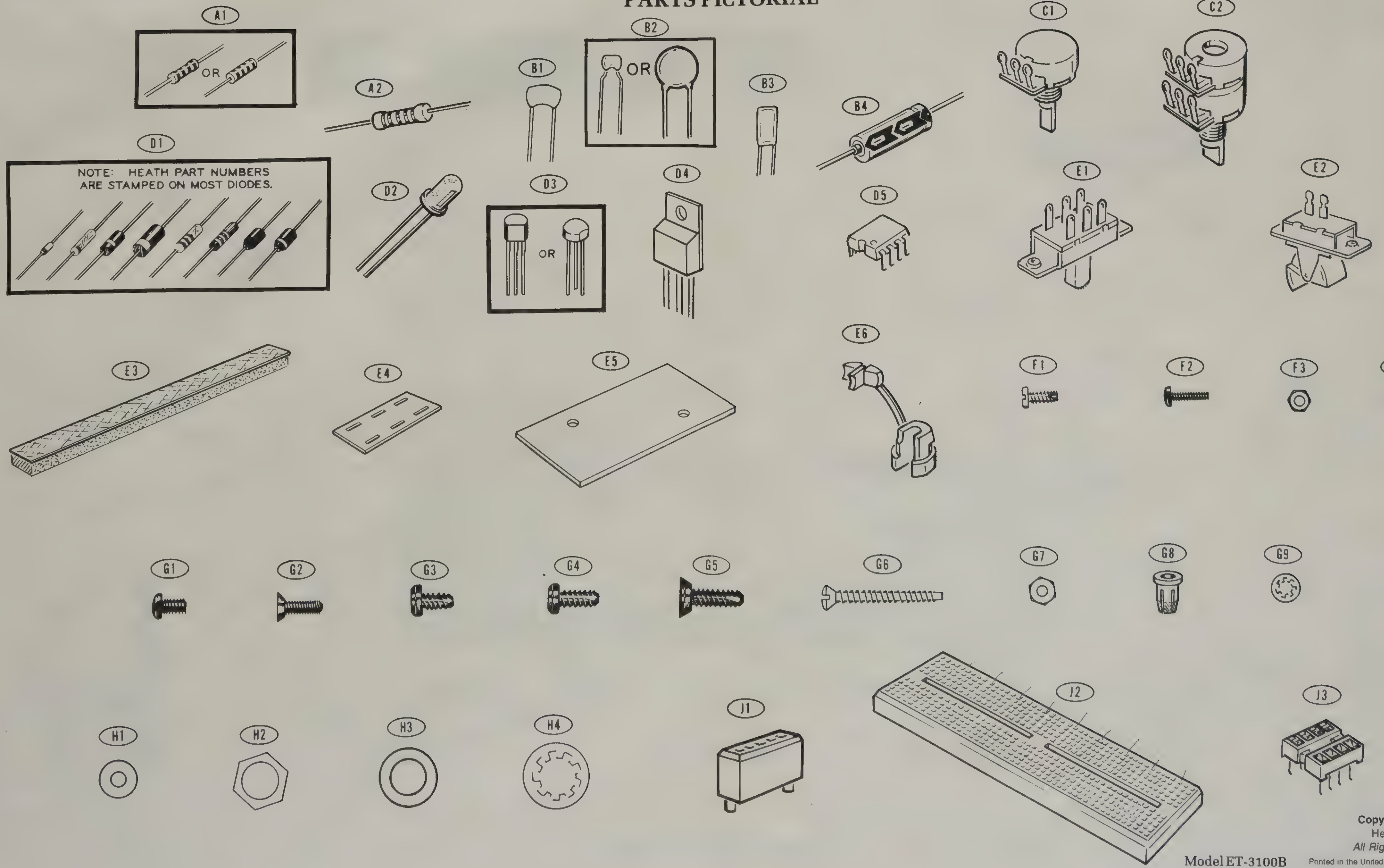
CIRCUIT COMP. NO.	HEATH PART NO.	MANUFACTURER'S NUMBER	BASE DIAGRAM
D1, D2, D106, D116	56-56	1N4149	 IMPORTANT: THE BANDED END OF DIODES CAN BE MARKED IN A NUMBER OF WAYS. BANDED END (CATHODE)
ZD1, ZD2	56-99	1N5223B	
ZD101, ZD111	56-620	1N4744A	
D101, D102, D103, D104	57-65	1N4002	
V101	412-640	LST5053	
Q111, Q113, Q114	417-235	2N4121	
Q1, Q3, Q101, Q103, Q104	417-801	MPSA20	
Q102	417-856	MJE5979	
Q112	417-857	MJE5976	
IC1, IC2	442-39	LM301	 COMP +Vcc OUTPUT OFFSET NULL (N2) 8 7 6 5 − + 1 2 3 4 OFFSET NULL/COMP (N1) INV INPUT NON-INV INPUT Vcc

ILLUSTRATION BOOKLET

PARTS PICTORIAL



Model ET-3100B

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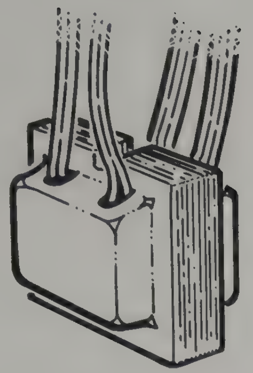
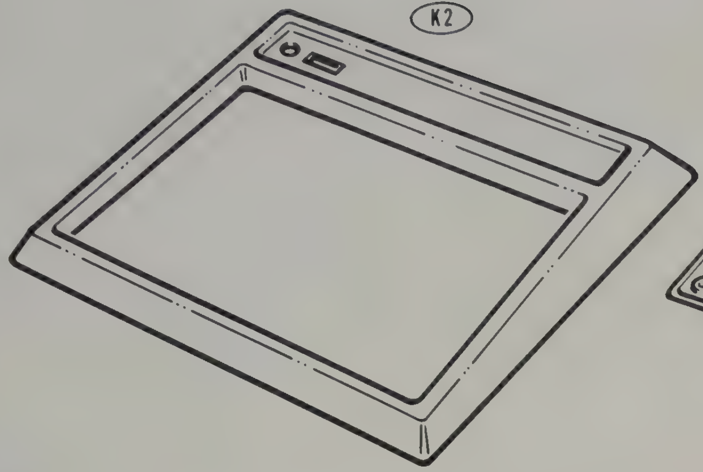
Parts Pictorial (Cont'd.)

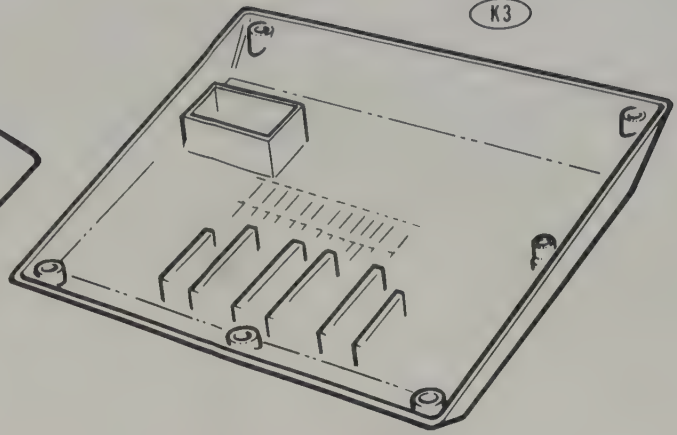
K1



K2



K3



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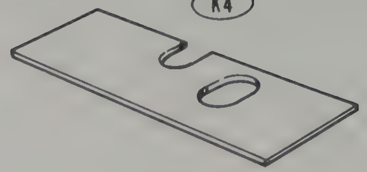

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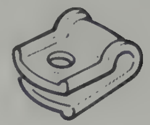

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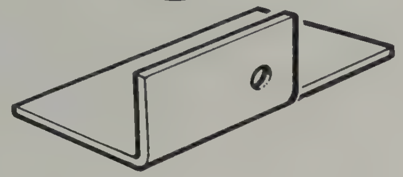

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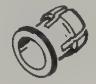
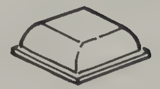
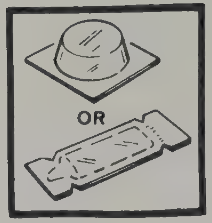


K8



K9



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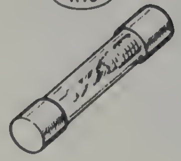

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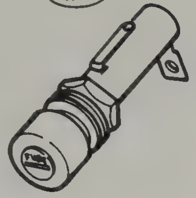

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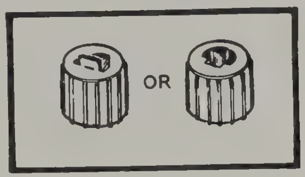

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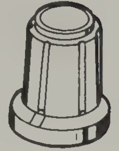

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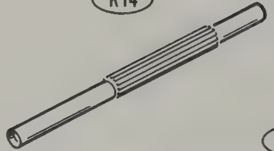

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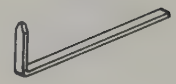
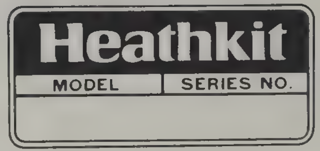
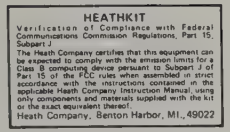


K19


Heathkit
MODEL
SERIES NO.

K16



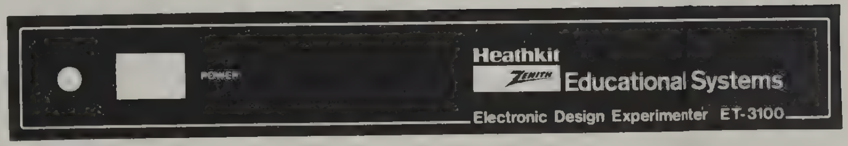
HEATHKIT

Verification of Compliance with Federal Communications Commission Regulations, Part 15, Subpart J

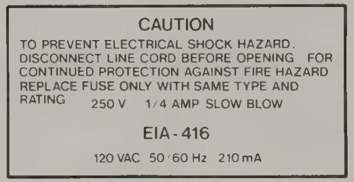
The Heath Company certifies that this equipment can be expected to comply with the emission limits for a Class B computing device persuant to Subpart J of Part 15 of the FCC rules when assembled in strict accordance with the instructions contained in the applicable Heath Company Instruction Manual, using only components and materials supplied with the kit or the exact equivalent thereof.

Heath Company, Benton Harbor, MI., 49022

K17



K18



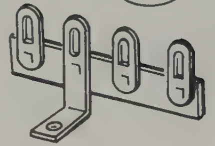
CAUTION

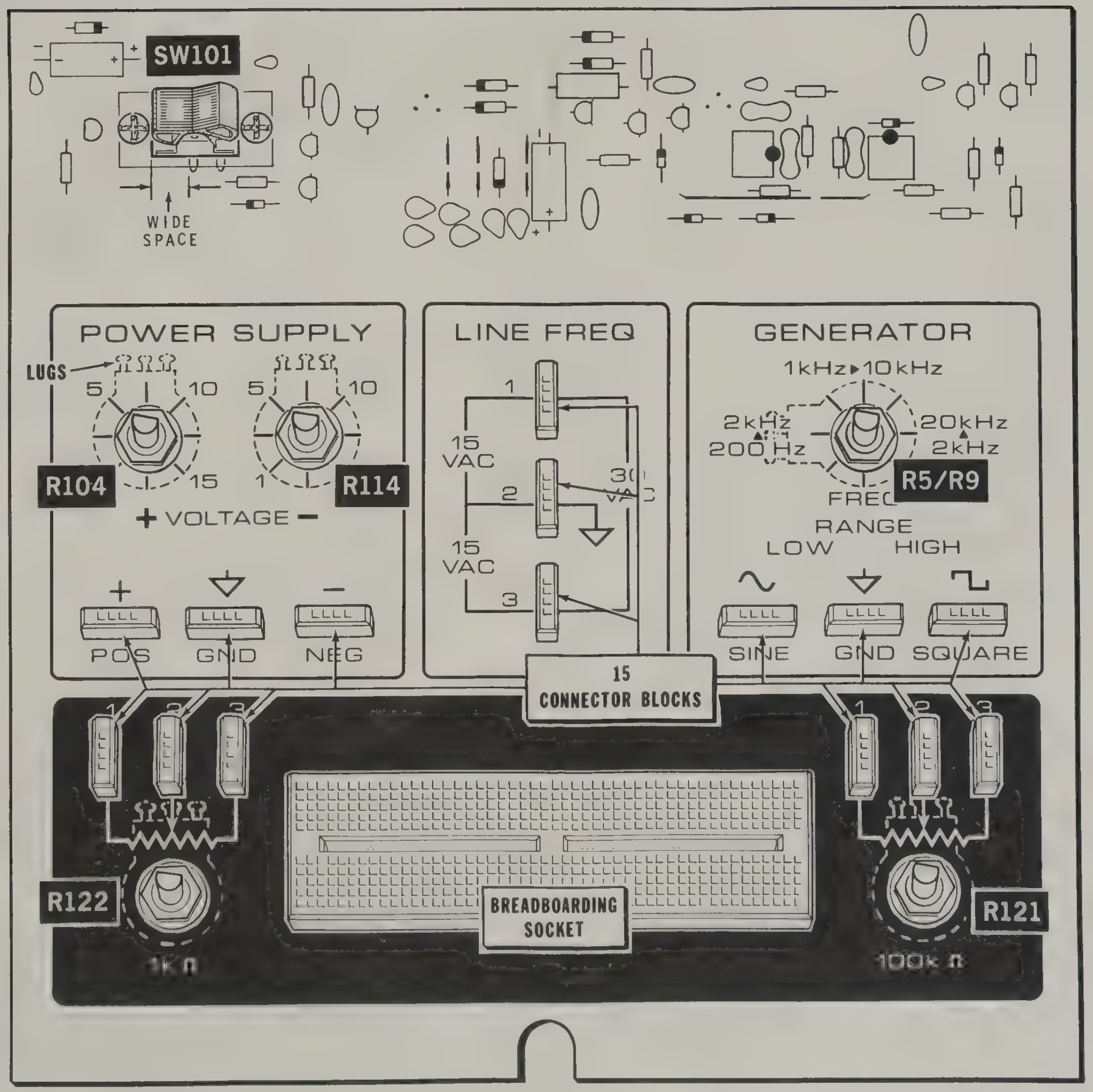
TO PREVENT ELECTRICAL SHOCK HAZARD, DISCONNECT LINE CORD BEFORE OPENING. FOR CONTINUED PROTECTION AGAINST FIRE HAZARD REPLACE FUSE ONLY WITH SAME TYPE AND RATING 250 V 1/4 AMP SLOW BLOW

EIA-416

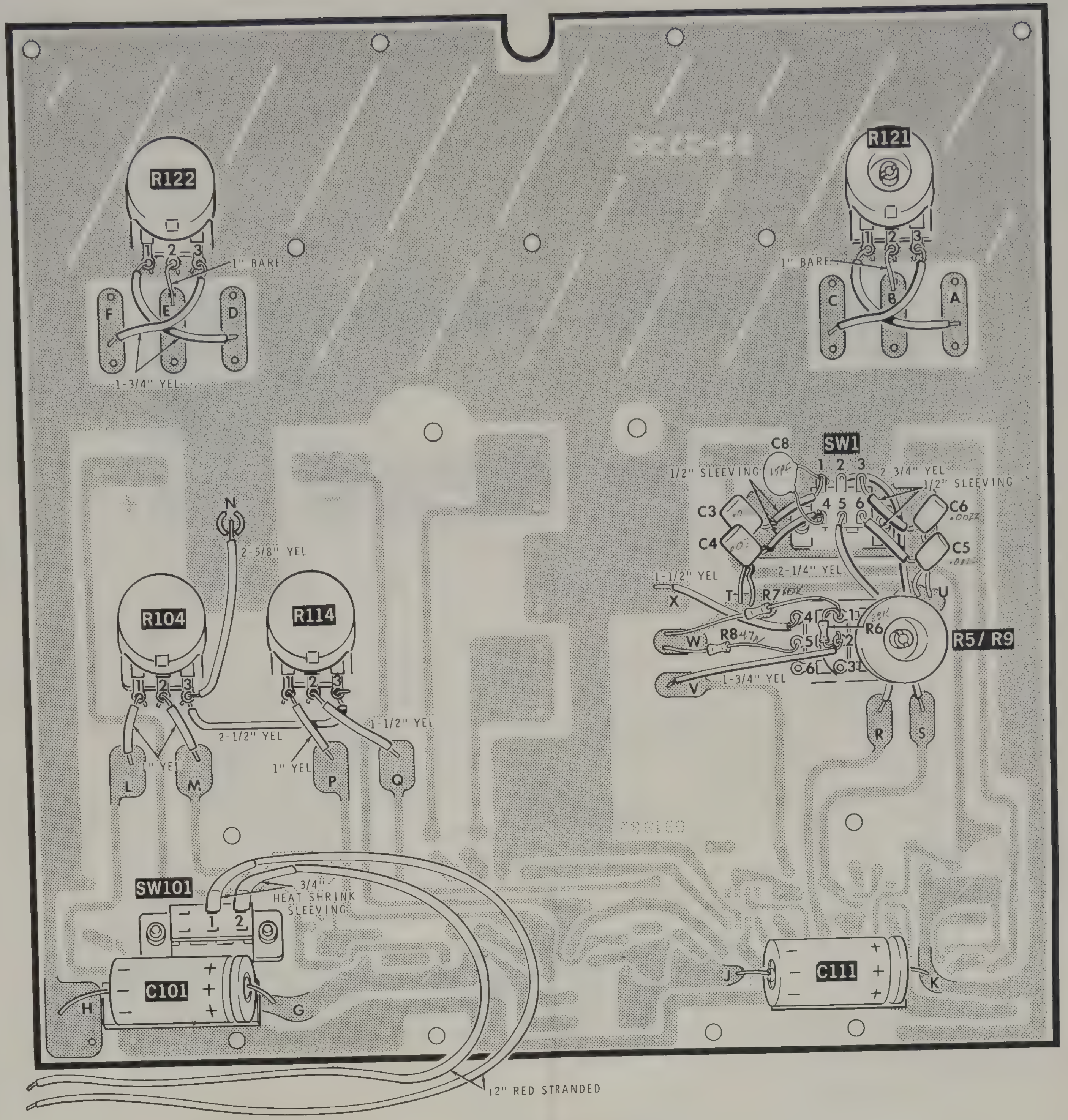
120 VAC 50/60 Hz 210 mA

K20

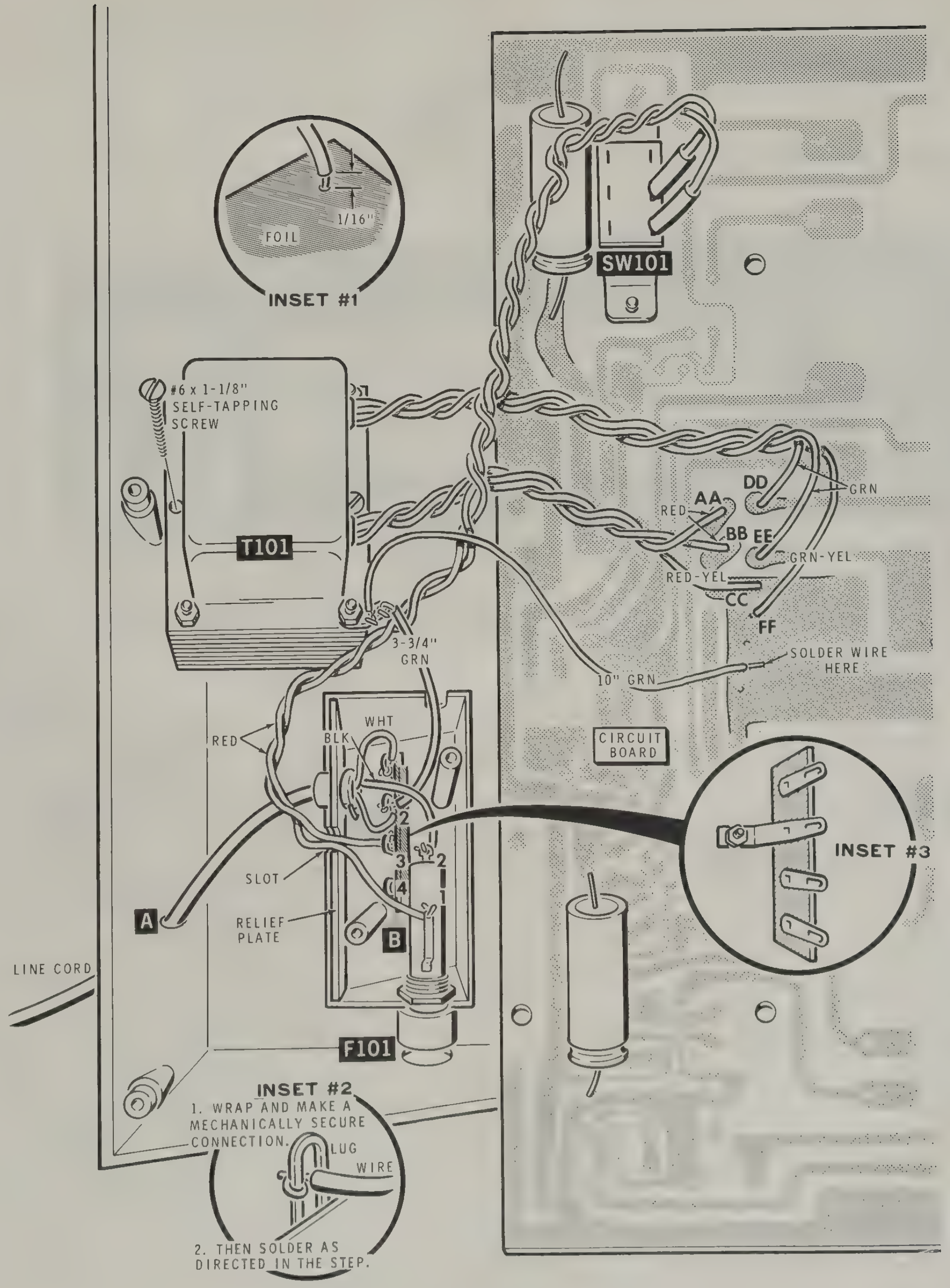




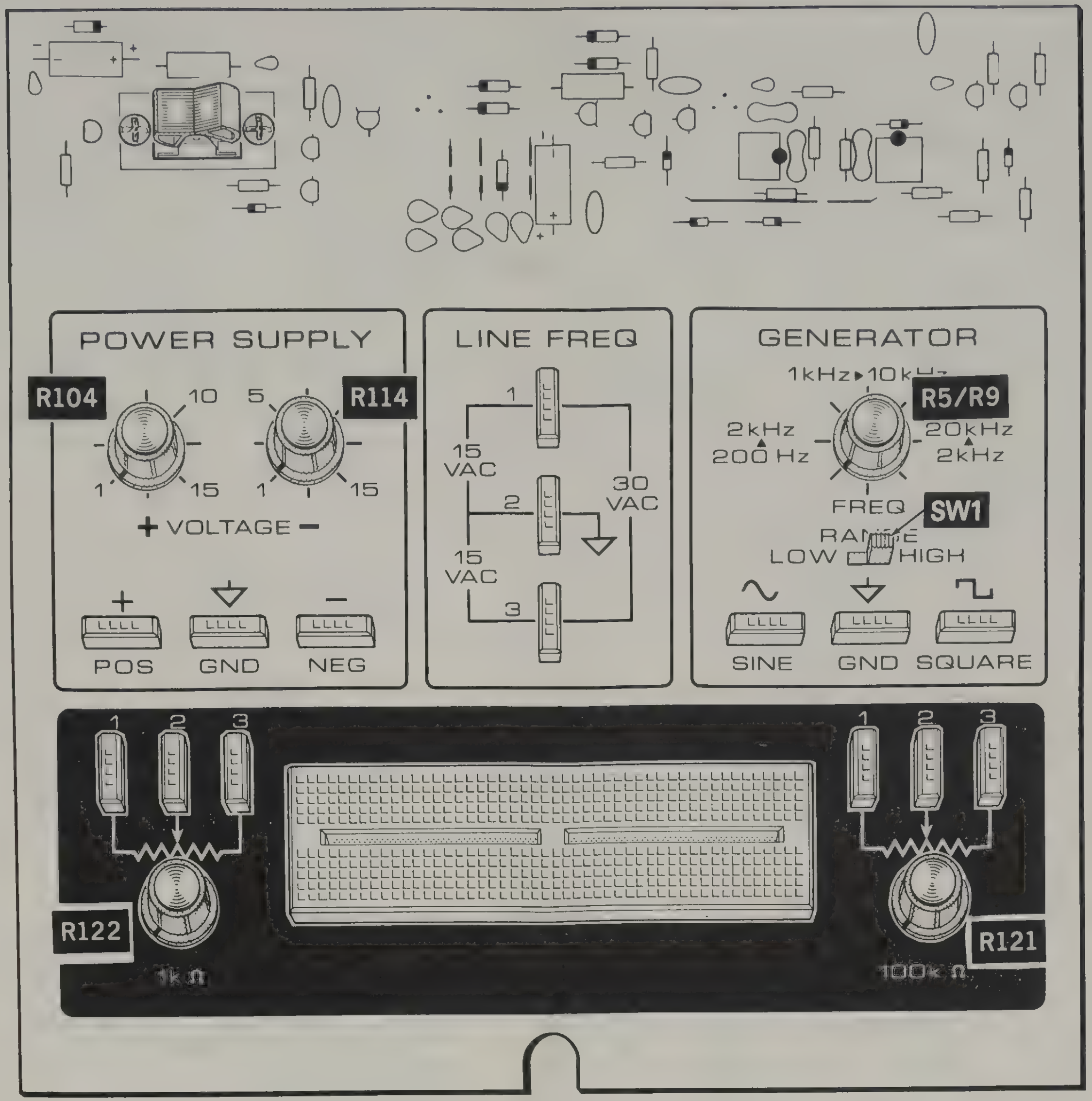
PICTORIAL 1-7



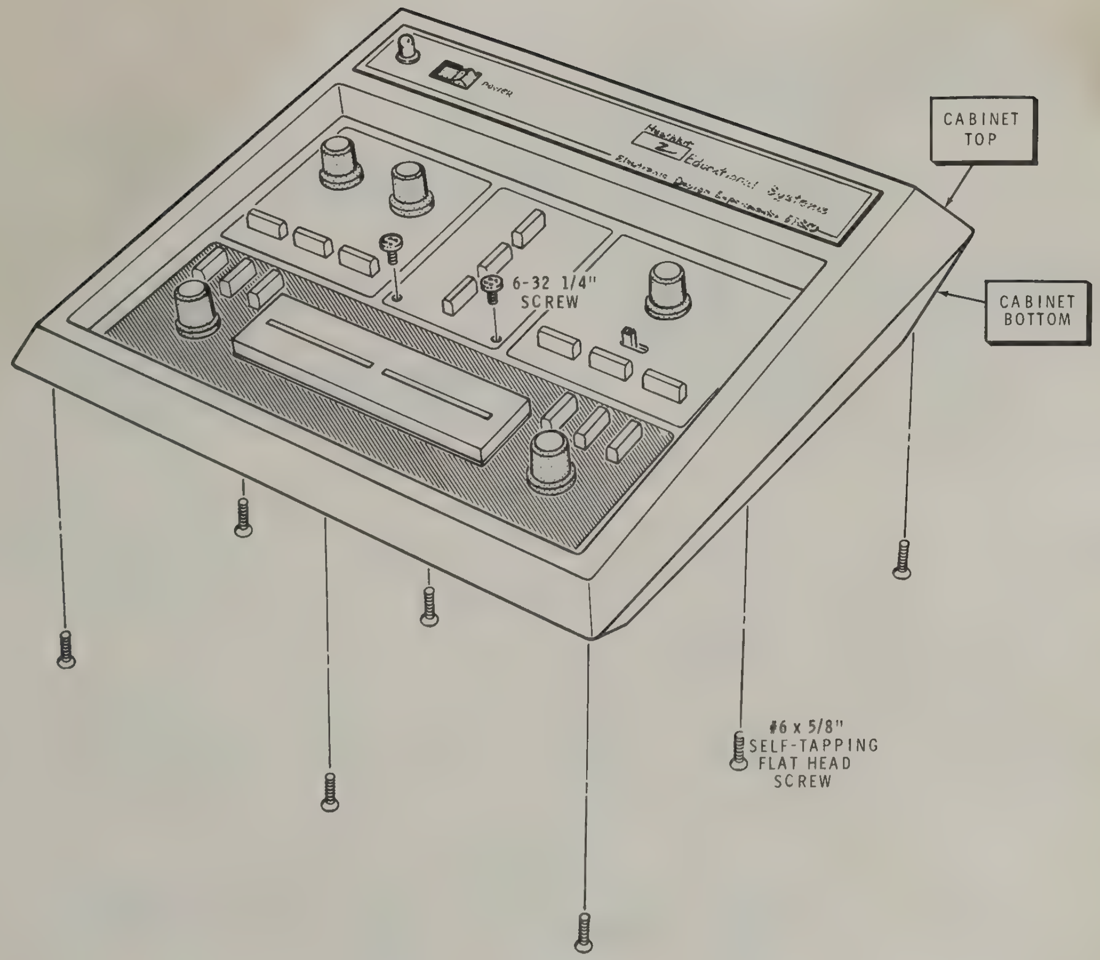
PICTORIAL 1-8



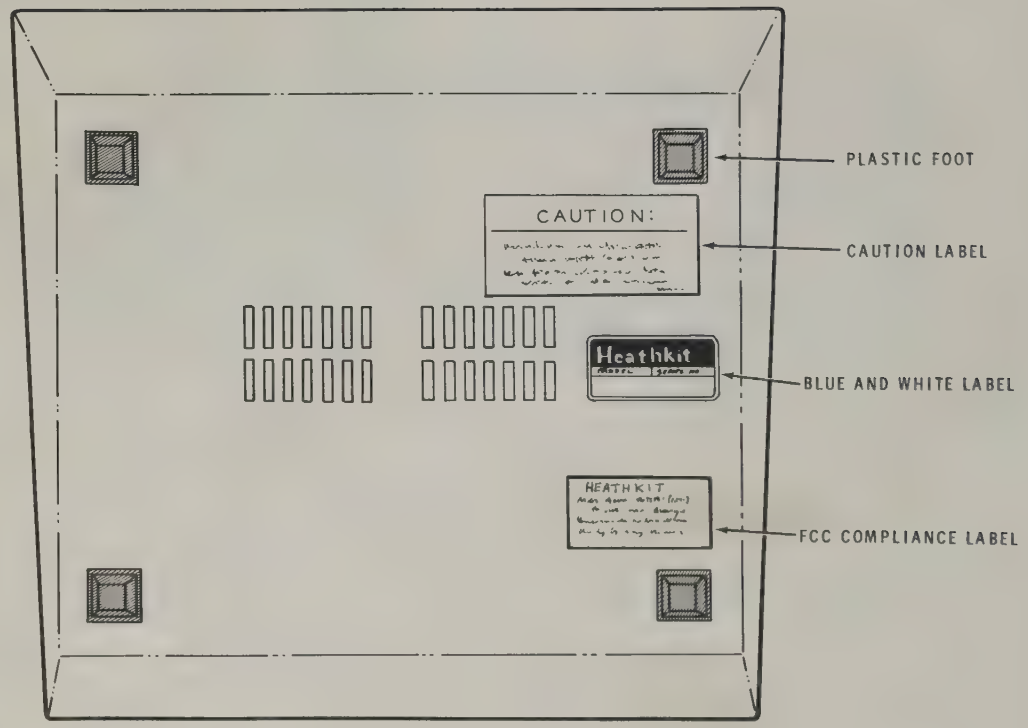
PICTORIAL 2-1



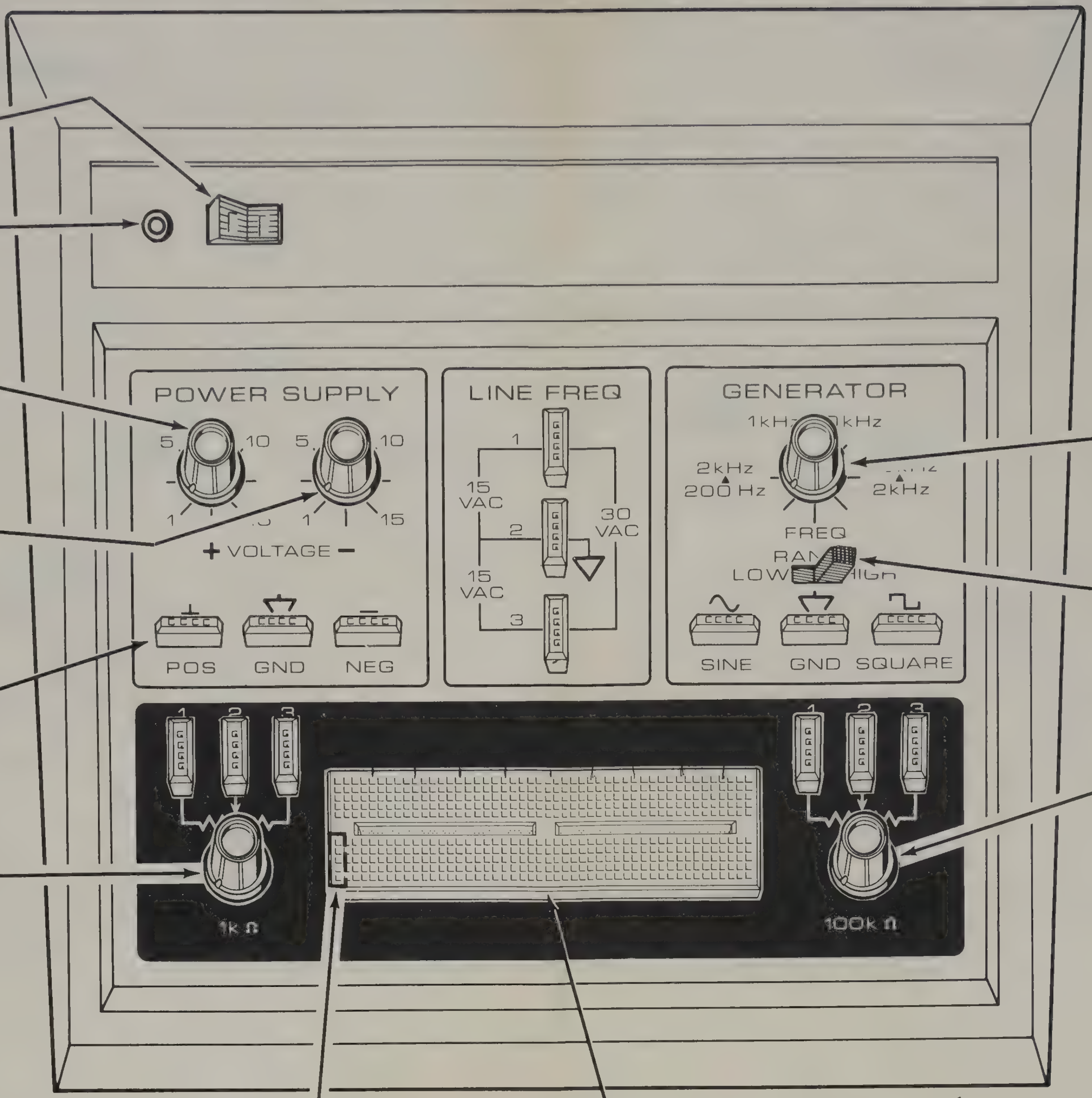
PICTORIAL 2-3



PICTORIAL 4-3



PICTORIAL 4-4



POWER switch (SW101) — Turns the unit on and off.

PILOT LAMP (V101) — Indicates when the unit is turned on.

POSITIVE control (R104) — Adjusts the output of the positive power supply.

NEGATIVE control (R114) — Adjusts the output of the negative power supply.

CONNECTOR BLOCKS — Use these to make solderless connections. The four connectors are internally connected together.

1 KΩ control (R122) — Use this variable resistor in your experiments.

FREQUENCY control (R5/R9) — Varies the frequency of the signal generator.

RANGE switch (SW1) — Selects the frequency range of the signal generator.

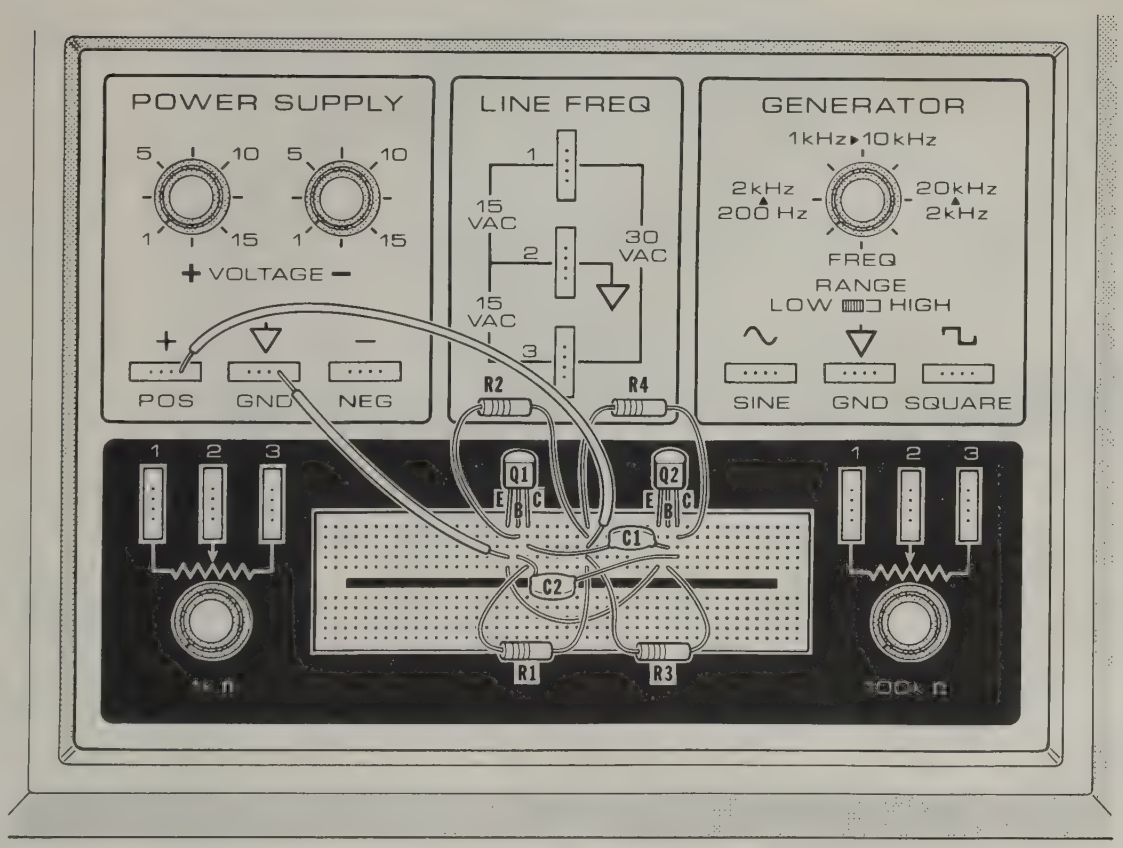
100 KΩ control (R121) — Use this variable resistor in your experiments.

The five connectors of each row are internally connected together.

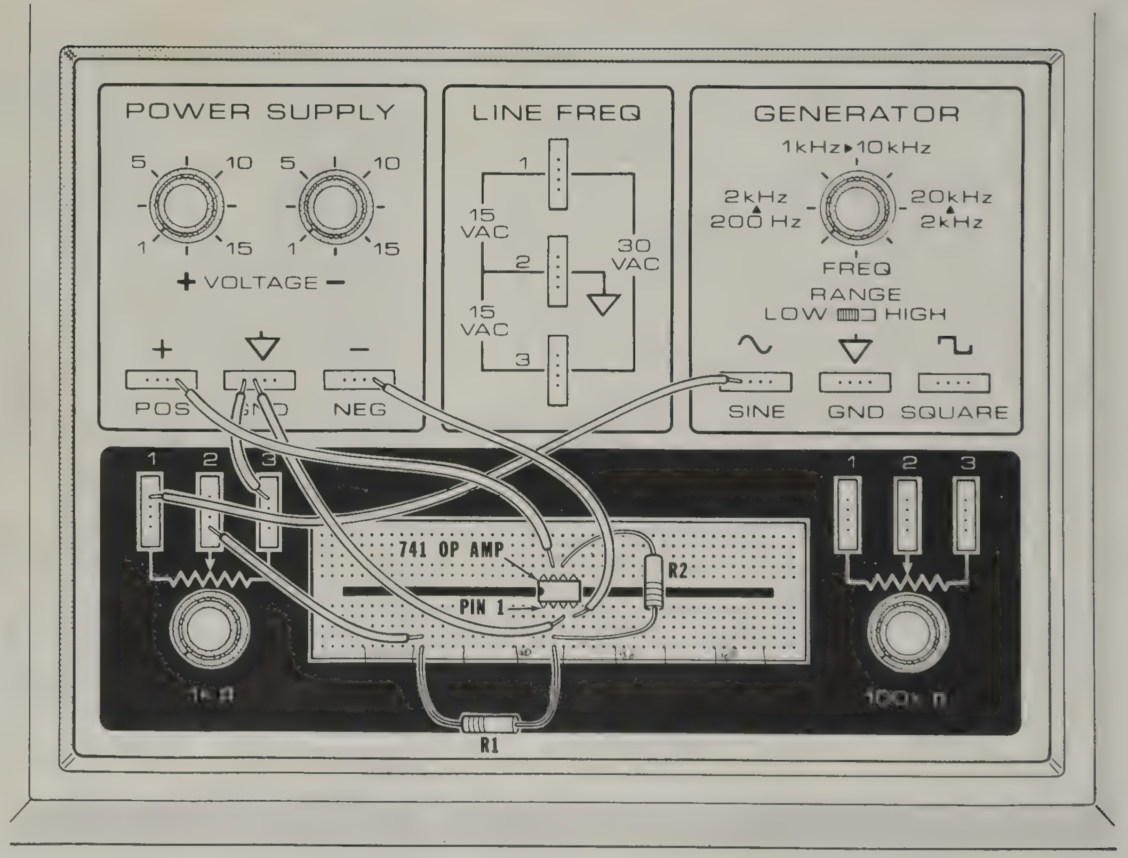
BREADBOARDING SOCKET — Use this to make solderless connections.

LOOKS LIKE
48PINS X 5PINS X 2 SETS

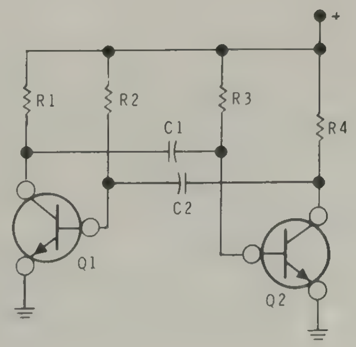
PICTORIAL 5-1



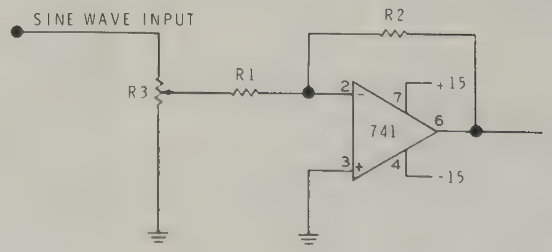
Experiment 1



Experiment 2

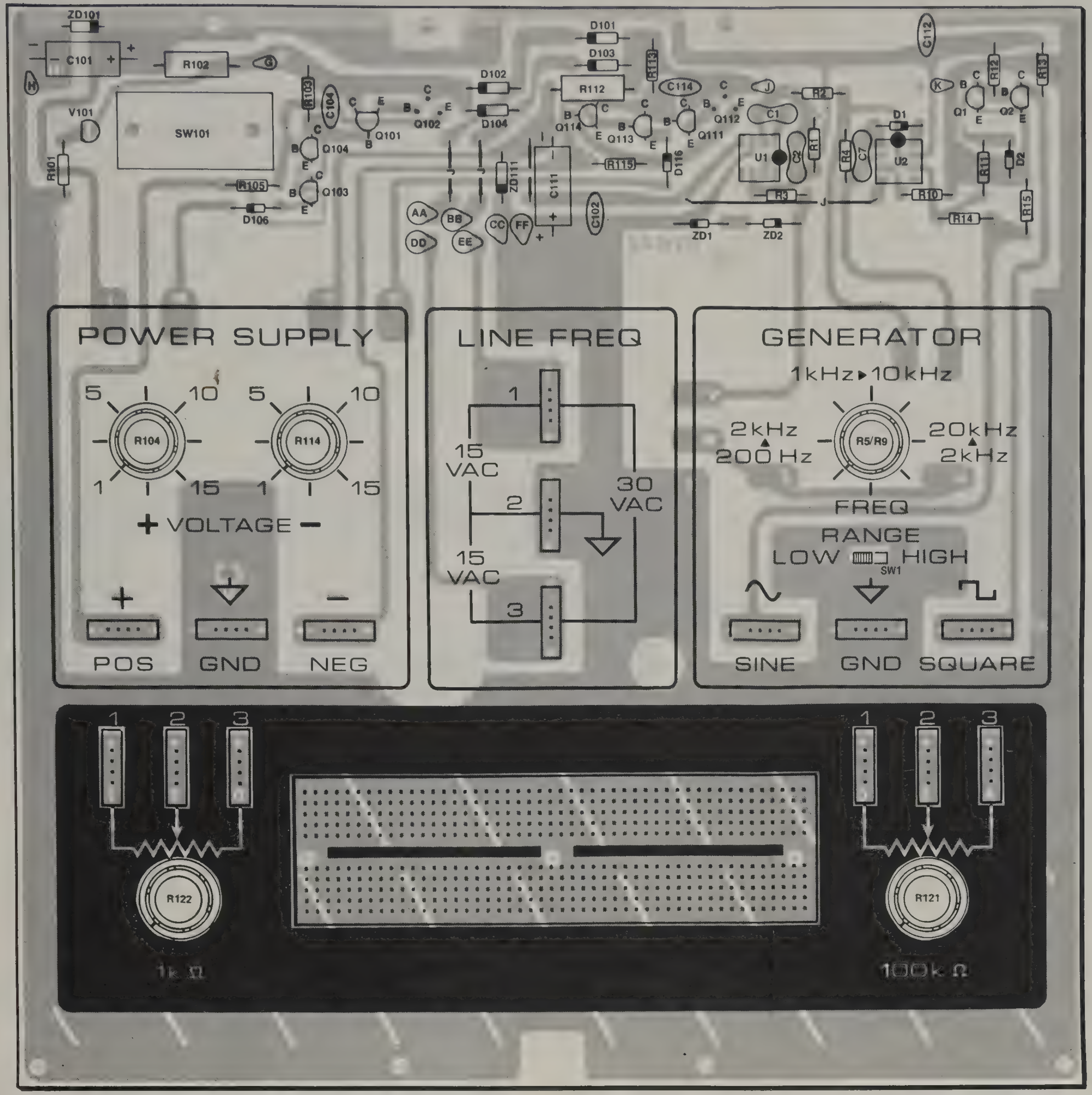


Schematic for Experiment 1



Schematic for Experiment 2

CIRCUIT BOARD X-RAY VIEWS

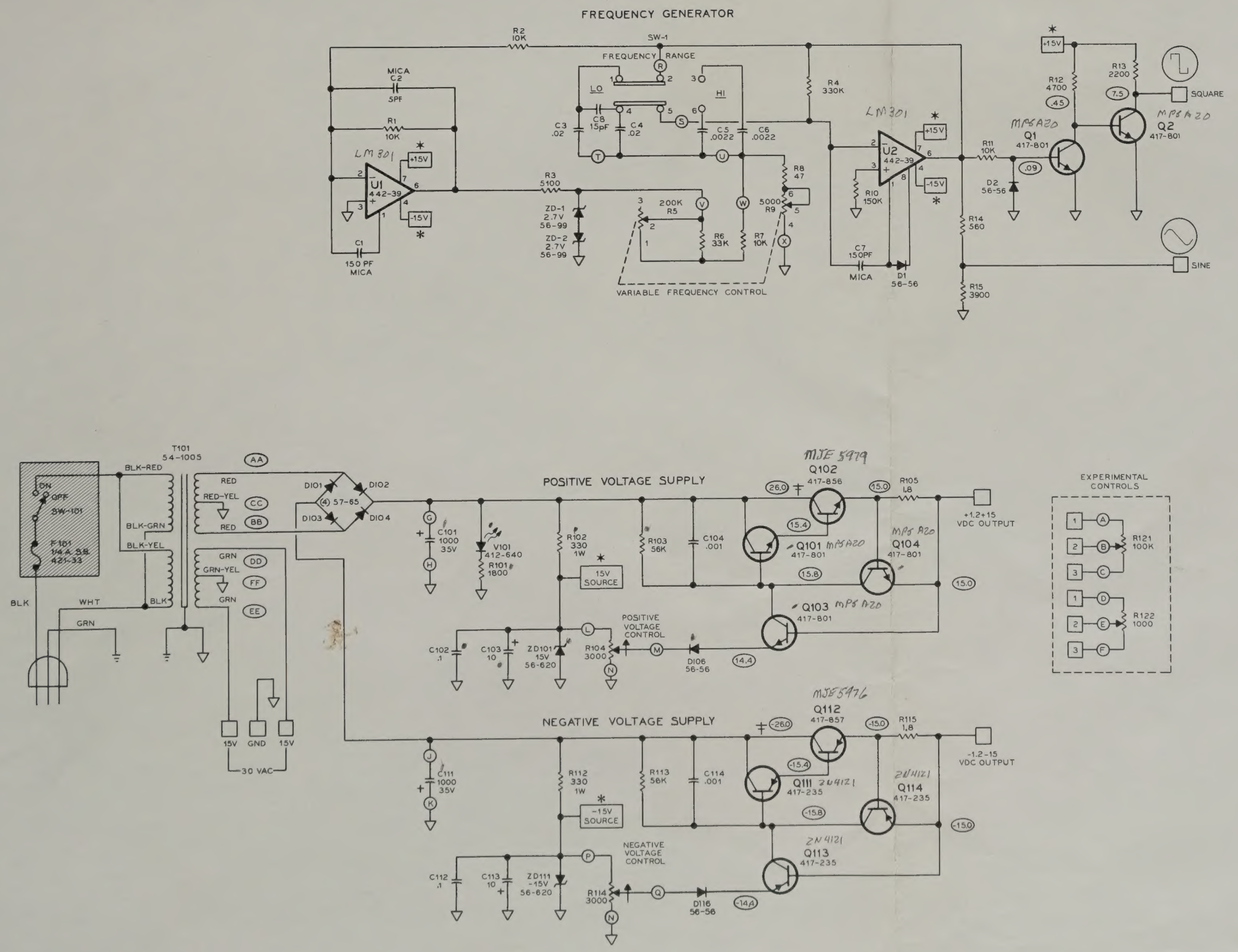


NOTE: To find the PART NUMBER of a component for the puropse of ordering a replacement part:

A. Find the circuit component number (R105,C103, etc) on the "Circuit Board X-Ray Views."

B. Locate this same number in the "Circuit Component Number" column of the "Parts List."

C. Adjacent to the circuit component number, you will find the PART NUMBER and DESCRIPTION which must be supplied when you order a replacement part.



NOTES:

1. COMPONENT NUMBERS ARE IN THE FOLLOWING GROUPS:

   1-99 PARTS IN THE SIGNAL GENERATOR.
   101-199 PARTS IN THE POWER SUPPLIES AND TWO EXPERIMENTAL CONTROLS.

2. ALL RESISTORS ARE 1/4 WATT UNLESS STATED OTHERWISE. RESISTOR VALUES ARE IN OHMS (K=1000; M=1,000,000).

3. ALL CAPACITOR VALUES ARE IN µF.

4. ◯ THIS SYMBOL INDICATES A DC VOLTAGE TAKEN WITH A HIGH IMPEDANCE VOLTMETER FROM THE POINT INDICATED TO CHASSIS GROUND.

5. ✶ THIS SYMBOL INDICATES A CONNECTION TO THE +15 VOLT SOURCE- NOT THE VARIABLE DC OUTPUT.

6. ✱ THIS SYMBOL INDICATES A CONNECTION TO THE -15 VOLT SOURCE- NOT THE VARIABLE DC OUTPUT.

7. Ⓐ THIS SYMBOL INDICATES A CIRCUIT BOARD CONNECTION POINT.

8. ‡ THIS SYMBOL INDICATES A VOLTAGE THAT WILL VARY AS THE LOAD AND LINE VOLTAGE VARY.

9. ↑ THIS SYMBOL INDICATES THE CLOCKWISE ROTATION OF A CONTROL.

10. POWER SUPPLY VOLTAGES WERE TAKEN WITH BOTH OUTPUTS ADJUSTED TO 15 VOLTS.

11. PARTS IN SHADED AREAS ARE CRITICAL FOR CONTINUED SAFETY. REPLACE THEM ONLY WITH PARTS OF THE SAME RATING OR WITH THE PROPER HEATH PARTS.

Schematic of the
HEATHKIT®
ELECTRONIC DESIGN
EXPERIMENTER
Model ET-3100B

CUSTOMER SERVICE

REPLACEMENT PARTS

Please provide complete information when you request replacements from either the factory or Heath Electronic Centers. Be certain to include the **HEATH** part number exactly as it appears in the parts list.

ORDERING FROM THE FACTORY

Print all of the information requested on the parts order form furnished with this product and mail it to Heath. For telephone orders (parts only) dial 616 982-3571. If you are unable to locate an order form, write us a letter or card including:

- Heath part number.
- Model number.
- Date of purchase.
- Location purchased or invoice number.
- Nature of the defect.
- Your payment or authorization for COD shipment of parts not covered by warranty.

Mail letters to:
Heath Company
Benton Harbor
MI 49022
Attn: Parts Replacement

Retain original parts until you receive replacements. Parts that should be returned to the factory will be listed on your packing slip.

OBTAINING REPLACEMENTS FROM HEATH ELECTRONIC CENTERS

For your convenience, "over the counter" replacement parts are available from the Heath Electronic Centers listed in your catalog. Be sure to bring in the original part and purchase invoice when you request a warranty replacement from a Heath Electronic Center.

TECHNICAL CONSULTATION

Need help with your kit? — Self-Service? — Construction? — Operation? — Call or write for assistance. you'll find our Technical Consultants eager to help with just about any technical problem except "customizing" for unique applications.

The effectiveness of our consultation service depends on the information you furnish. Be sure to tell us:

- The Model number and Series number from the blue and white label.
- The date of purchase.
- An exact description of the difficulty.
- Everything you have done in attempting to correct the problem.

Also include switch positions, connections to other units, operating procedures, voltage readings, and any other information you think might be helpful.

Please do not send parts for testing, unless this is specifically requested by our Consultants.

Hints: Telephone traffic is lightest at midweek — please be sure your Manual and notes are on hand when you call.

Heathkit Electronic Center facilities are also available for telephone or "walk-in" personal assistance.

REPAIR SERVICE

Service facilities are available, if they are needed, to repair your completed kit. (Kits that have been modified, soldered with paste flux or acid core solder, cannot be accepted for repair.)

If it is convenient, personally deliver your kit to a Heathkit Electronic Center. For warranty parts replacement, supply a copy of the invoice or sales slip.

If you prefer to ship your kit to the factory, attach a letter containing the following information directly to the unit:

- Your name and address.
- Date of purchase and invoice number.
- Copies of all correspondence relevant to the service of the kit.
- A brief description of the difficulty.
- Authorization to return your kit COD for the service and shipping charges. (This will reduce the possibility of delay.)

Check the equipment to see that all screws and parts are secured. (Do not include any wooden cabinets or color television picture tubes, as these are easily damaged in shipment. Do not include the kit Manual.) Place the equipment in a strong carton with at least THREE INCHES of *resilient* packing material (shredded paper, excelsior, etc.) on all sides. Use additional packing material where there are protrusions (control sticks, large knobs, etc.). If the unit weighs over 15 lbs., place this carton in another one with 3/4" of packing material between the two.

Seal the carton with reinforced gummed tape, tie it with a strong cord, and mark it "Fragile" on at least two sides. Remember, the carrier will not accept liability for shipping damage if the unit is insufficiently packed. Ship by prepaid express, United Parcel Service, or insured Parcel Post to:

Heath Company
Service Department
Benton Harbor, Michigan 49022

HEATH
ZENITH

HEATH COMPANY • BENTON HARBOR, MICHIGAN

THE WORLD'S FINEST ELECTRONIC EQUIPMENT IN KIT FORM

LITHO IN U.S.A.